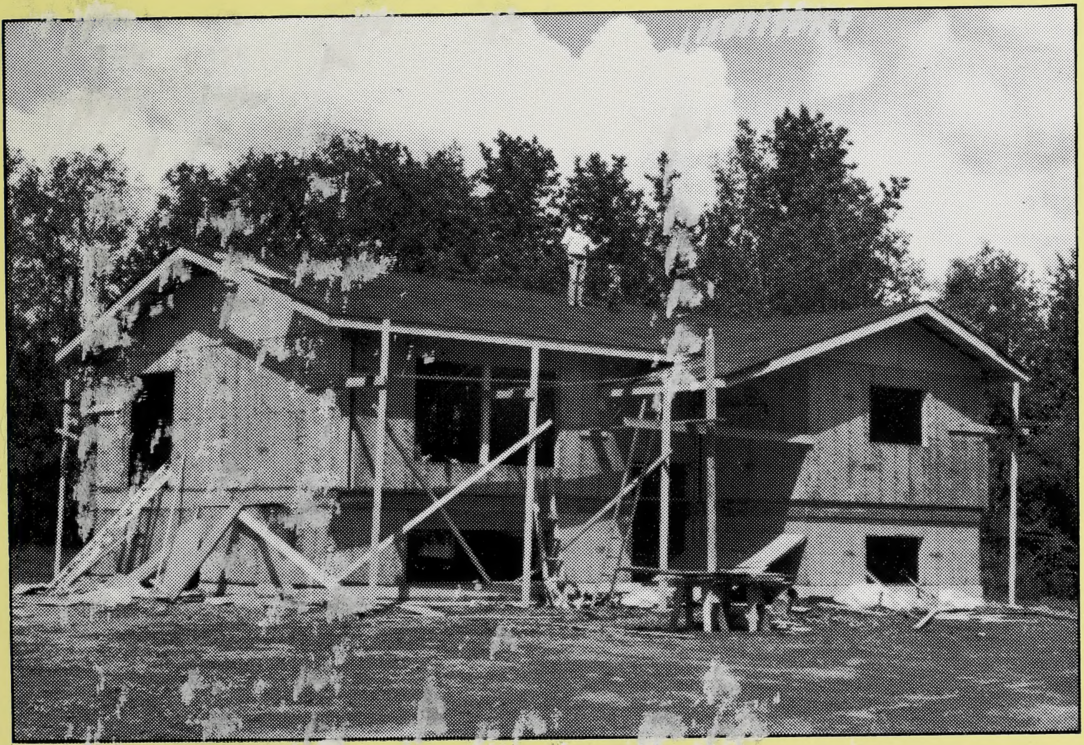
BUILDING CONSTRUCTION 12



ALBERTA CORRESPONDENCE SCHOOL
ALBERTA EDUCATION

Building Construction 12

LESSONS 1-20

Distance Learning

Alberta EDUCATION

Building Construction 12
Student Module
Lessons 1-20
Alberta Correspondence School
ISBN No. 0-7741-0614-X

INTRODUCTION

Tools
Non-liability of School
General Instructions
Evaluation Procedure
Metric Units

Building Construction 12 is an introductory course which covers some of the basic skills of the building trades. The emphasis is on the use and maintenance of hand tools plus the mathematical theory relating to construction. As well, information on construction materials and power tools is included.

There is no textbook for the Building Construction 12 course. All information is contained in the lessons themselves. General references relating to carpentry and construction would be helpful to the student who wants to advance his skill and knowledge beyond the scope of this course.

TOOLS

The practical project assignment (Lesson 16) should be completed using the tools discussed in the previous lessons. If inferior or substitute tools are used, the working conditions and procedures should be described to your correspondence teacher so he will be able to judge you work more fairly. The basic tools required include:

- claw hammer
- bench or block plane
- cross cut hand saw
- steel square
- paint brush
- nail set
- screwdriver

NON-LIABILITY OF THE SCHOOL

While extreme care has been taken in preperation of the practical work the Alberta Correspondence School cannot be responsible for any injury which results from you working on the project. You must be willing to accept responsiblity for your own actions in this regard.

GENERAL INSTRUCTIONS

(a) When you receive the course, take it apart carefully so that the pages will remain untorn. If you open the book firmly in the middle, the staples will separate and the book will come apart. You can then remove the whole pages without tearing them. Use rings to keep the pages together in the right order.

(b) Try to form good habits of study. After you have read the assigned pages, read through the exercises. See how well you can answer them. If you have difficulty with any of the exercises, you may find it necessary to read the lesson material a second time.

(c) Before you start an exercise, be sure that you have read the instructions thoroughly so that you understand them.

(d) It is good practice to keep a record of the time you spend on your work. This course constitutes the work of an entire school year. It contains twenty lessons. There are forty weeks in a full school year. If you are on a 10 month school year you need to submit an average of one lesson every two weeks. If you are on a semester system you should submit a lesson every week. You can send a lesson as soon as you have finished it. That way it will get marked faster and you will get it back sooner.

(e) When a lesson is returned to you, study the corrections and comments made by the teacher. Find out what parts of your work have been good and what parts could be improved. Try to benefit from the corrections. Similar mistakes in successive lessons indicate that the student is not giving sufficient attention to the corrections.

(f) Avoid using abbreviations, ditto marks, and the symbol '&' for the conjunction 'and' in your written answers. All words should be written in full.

(g) Before sending a lesson for correction, check to be sure that all exercises are completed, or at least attempted. Do not leave any questions blank or with just a ? written in. They will be returned with an 'F'. Please, do all questions.

(h) Please use dark ink for all written exercises. Do not write with pencil or colored ink. Avoid writing with pencil first and then going over the work with ink.

(i) When submitting your lessons, send only those pages on which there are written answers. Pages containing only teaching notes should not be submitted.

EVALUATION PROCEDURE

All students registered in Building Construction 12 who have completed the required basic number of lessons plus the project will have their course mark evaluated as indicated below. The evaluation is out of 100 percent.

(a) The project in Lesson 16 carries a weight of 25 percent

(b) The other lessons carry a weight of 15 percent

(c) The final exam carries a weight of 60 percent.

In summary

Project	- 25 percent
Lessons	- 15 percent
Final Exam	- 60 percent

NOTE If your mark on the final test is less than 40%, **no consideration** will be given for your year's work. Your final course mark will then be based entirely on the final test.

METRIC UNITS

The course is written using SI units exclusively. The table of prefixed shown below is a reference guide so you can easily understand what metric prefixes mean.

Prefix	Symbol	Meaning	Multiplier	
*kilo	k	one thousand	1 000	$= 10^3$
hecto	h	one hundred	100	$= 10^2$
deca	da	ten	10	$= 10^1$
*		one	1	$= 10^0$
deci	d	one tenth of a	0.1	$= 10^{-1}$
*centi	c	one hundredth of a	0.01	$= 10^{-2}$
*milli	m	one thousandth of a	0.001	$= 10^{-3}$
*Most commonly used.				

Below is an example of the unit of length (metre) and the prefixes commonly used with it.

UNIT	SYMBOL	MEANING	EXAMPLE
kilometre	km	10^3m	Length of brisk 10 min walk.
metre	m	1 m	Height of 3-drawer filing cabinet.
millimetre	mm	10^{-3}m	Thickness of a dime.

The table below is put in the order of most probable frequency of use. So units that would be used frequently are put first, and units less frequently toward the last.

QUANTITY	NAME	SYMBOL	NOTES
length	millimetre centimetre metre kilometre	mm cm m km	 A Volkswagen is about 4 m long.
area	square centimetre square metre	cm^2 m^2	
volume	cubic centimetre cubic metre millilitre litre	cm^3 m^3 mL L	1 cm by 1 cm by 1 cm 1000 mL = 1 L 1 L is the volume of a cube 10 cm by 10 cm by 10 cm.
mass	gram kilogram milligram tonne	g kg mg t	 1 t is 1 000 kg, this is about the mass of a Volkswagen.
temperature	degree Celsius	°C	A comfortable room has a temperature of 20°C.
time	hour minute second	h min s	
speed	kilometre per hour metres per second metres per hour	km/h m/s m/h	A good highway cruising speed would be 100 km/h.
pressure	pascal kilopascal	Pa kPa	 The atmospheric pressure is about 100 kPa.
force	newton	N	The newton is roughly the force required by your hand when supporting 2 golf balls.
rotational frequency	revolutions per minute	min^{-1}	An LP record has a rotational frequency of 33 min^{-1}, also written as r/min.
density	kilograms per cubic metre	kg/m^3	
relative density	The terms 'specific weight' and 'specific gravity' should be replaced by the term 'relative density'. Mercury has a relative density of 13.6, meaning that it is 13.6 times as dense as water. Water is implied as the reference substance for liquids and solids, and air for reference for gases, unless indicated otherwise.		

Below is a list of rules for writing SI Metric Units.

(a) The symbols are always printed in Roman (upright) type, irrespective of the type of face used in the rest of the text.

(b) Symbols are never pluralized: 45 g (not 45 gs)

(c) Never use a period after a symbol, except when the symbol occurs at the end of a sentence. This is done because SI symbols are SYMBOLS they are NOT abbreviations.

Example: the symbol for kilogram is kg NOT kg.

(d) Symbols should usually be used and unit names not mixed with symbols.

Example: 10 kg (preferred), ten kilograms (accepted), never 10 kilograms.

(e) Always use a full space between the quantity and the symbol: 45 g (not 45g)

Exception: For Celsius temperatures the degree sign occupies the space. 32°C (not 32° C or 32 °C)

(f) Use decimals, not fractions: 0.25 g (not 1/4 g) (the decimal is a point on the line in English).

(g) A zero is always used before a decimal marker: 0.45 g (not .45 g)

(h) Symbols are written in lower case, except when the unit is derived from a proper name:

m for metre; s for second; but N for newton; A for ampere; degree Celsius °C is the only one to be upper case in both name and symbol.

(i) Prefixes are printed in Roman (upright) type without spacing between the prefix and the unit symbol: kg for kilogram, km for kilometre

Only one prefix is applied at one time to a given unit: megagram or tonne, NOT kilokilogram

(j) Use spaces to separate long lines of digits into easily readable blocks of three digits with respect to the decimal marker: 32 453.246 072 5

Exception: A space is optional with a four-digit number: 1 234 or 1234

(k) Multiplication of Units in symbolic form is indicated by a dot at mid-letter height between the symbols.

(l) Division of Units in symbolic form is indicated by an oblique stroke between the symbols, or by a negative exponent.

TABLE OF CONTENTS

ADVANCE NOTICE CONCERNING TESTING AND COURSE EVALUATION

1. In order to be recommended for credits in Building Construction 12, you are required to write a supervised test set by the Alberta Correspondence School before registration expires. A portion of the final mark will be based on your course work, as evaluated by a teacher of the Alberta Correspondence School. If the final mark differs substantially from your year's work, the teacher will use discretion in balancing the composition of the marks in order to arrive at a fair assessment of achievement in the course. Appeal papers will be available to students who do not achieve a pass, and whose registration has not expired.

2. (a) **Classroom students**

Classroom students are those who are in attendance in school in Alberta and who are supplementing their school programs by taking one or more correspondence courses.

A student attending school does not submit an application for the final test. Test papers are sent automatically to the principal in January and June for writing before the end of the semester or at the end of August for writing during the first week of September for summer school students. At least **eighteen satisfactory lessons**, out of the twenty to be submitted, must be received by the Alberta Correspondence School before a test paper is mailed to the principal. As well, the project that is to be done with Lesson 16 **must** be submitted in order for the test to be sent. All twenty lessons should be submitted before the test is written, since you will lose marks for the course work portion if only eighteen or nineteen lessons are submitted.

The principal is in charge of scheduling final tests and all questions about scheduling should be directed to the principal.

If a test is not written before the expiry date of registration, the course is considered incomplete for the school year which the student registered.

(b) **Non-classroom students**

Non-classroom students are those who are studying exclusively by correspondence and are not registered in any subjects in an Alberta classroom.

To obtain course credits, non-classroom students must complete all required lessons and write the final test before the expiry date of registration. Information about expiry dates is given in the Information Bulletin which a student receives before filing an application for a correspondence course.

The application for the final test is sent out when the corrected Lesson 14 is returned to the student. The student submits the completed application with Lesson 18. The test is sent out after **eighteen satisfactory lessons**, out of twenty to be submitted, have been received by the Alberta Correspondence School. As well, the project that is to be done with Lesson 16 **must** be submitted in order for the test to be sent. All twenty lessons should be submitted before the test is written, since you will lose marks for the course work portion if only eighteen or nineteen lessons are submitted.

If a test is not written before registration expires, the course is considered incomplete for the school year during which the student registered.

NOTE - For the purpose of writing final tests, students who live outside Alberta come under the same regulations as those in category (b).

A LESSON RECORD FORM MUST BE COMPLETED FOR EVERY LESSON SUBMITTED FOR CORRECTION, AS ILLUSTRATED BELOW

A Lesson Record form with the **correct** label attached **must** be enclosed with **every lesson** submitted for correction, as illustrated below.

Correct use of these labels will ensure prompt processing and grading of your lessons.

The enclosed **Lesson Labels** must be checked for spelling and address details.

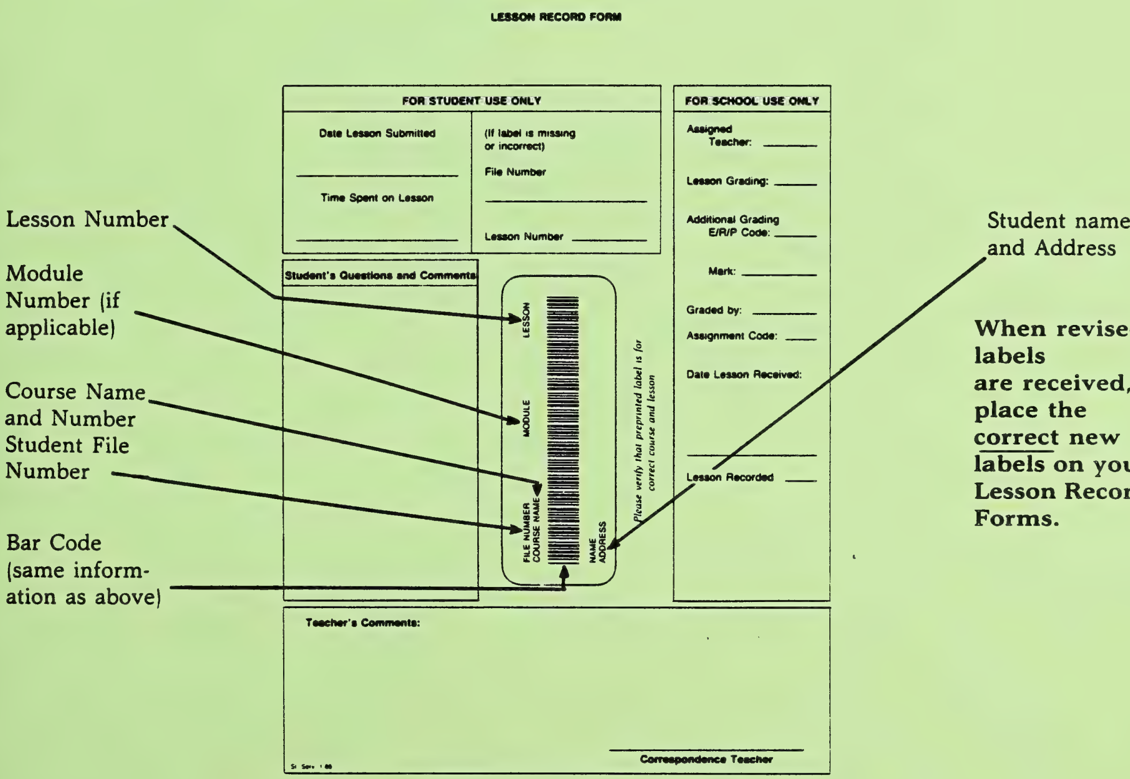
Please advise the Alberta Correspondence School promptly of any changes in name, address, school, or any other details and we will issue a revised set of labels. Your file number is permanently assigned and **must** be included on all correspondence with the Alberta Correspondence School. If the proper label and Lesson Record Form is not attached to each lesson as indicated it will delay your lessons being processed and credited to you.

Lesson labels are to be attached to the **lesson record forms** in the space provided for student name and address.

Check carefully to ensure that the **subject name, module number** and **lesson number** on each label corresponds exactly with the lesson you are submitting.

Labels are to be **peeled** off waxed backing paper and **stuck** on the lesson record form.

Only **one** label is to be placed on each lesson.



When revised labels are received, place the correct new labels on your Lesson Record Forms.

DO NOT MARK OR COVER BAR CODING.

CHANGE OF ADDRESS

If the address on your lesson record form differs from the address you supplied on your registration application, please explain. Indicate whether the different address is your home, school, temporary or permanent change of address.

St.Serv. 3-88

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

____

(If label is missing
or incorrect)

File Number

____

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned
Teacher: ________

Lesson Grading: ________

Additional Grading
E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ______

Date Lesson Received:

____

Lesson Recorded ______

Student's Questions and Comments

Apply Lesson Label Here

Name ____

Address ____

Postal Code ____

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____

Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

MEASURING, LAYOUT AND MARKING TOOLS

push pull rule	sliding T-level
steel tape	compas
folding rule	divider
framing square	trammel points
combination square	pencils
try square	utility knife
marking gauge	

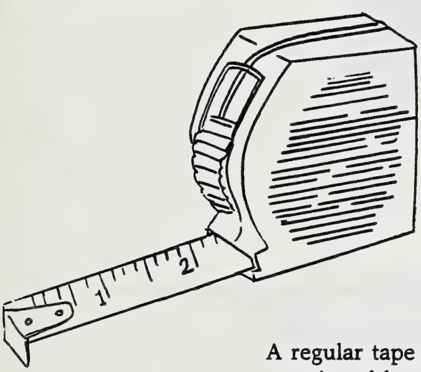
INTRODUCTION

Most technical courses are considered easy if the people taking them are interested in the material being covered. They do however cover much factual material which has to be learned before a person can consider themselves an expert in the area.

This lesson on measuring, layout and marking tools is no exception. If tools are forgotten about, or not used correctly when measuring on a project, the job may turn out sloppy looking. The information presented in this lesson is to help the student learn which tools are available and how they are used. By knowing what each of the tools will do, you will be able to choose the best one for the job.

VARIOUS MEASURING, LAYOUT AND MARKING TOOLS

1. Push Pull Rule (pocket rule or tape measure)



This is the most common measuring device used in carpentry today. It is also found in most homes and is used for a variety of measuring jobs.

The commerical sizes vary from 6.4 mm by 2 m to 20 mm by 8 m (the first figure is the width of the blade and the second one is the length of the blade). However the most common size is 20 mm by 5 m. This is the most useful, but yet not to cumbersome, size for a carpenter to carry. The wide tape is also superior (especially for distances over one meter) because it does not bend or flop as easily.

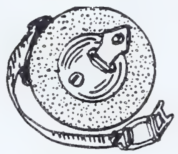
A regular tape measure is handier than either a four-fold rule or zig zag rule (these are mentioned later) because it is much easier to carry in a carpenter's apron and can be used for a wider range of measurements.

The push pull rule can be used for straight measuring as well as for measuring the circumference of cylindrical objects such as plumbers drain pipes, electrical conduits and tinsmith's heating ducts.

Remember when doing inside measurements between the two objects, you have to add the length of the case to your tape reading. The length of the case is written on the case usually in the form "ADD 50 mm" but make sure to check your tape to see exactly what value to add.

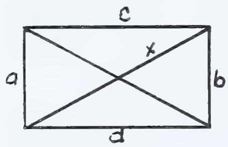
Also do not allow a tape to race back into the case and hit the hook as this will eventually tear the hook off the blade.

2. Steel tapes



Steel tapes are usually available in two lengths, 15 m and 30 m. They are used for long accurate measurements such as the length of a garage or a house, or measuring lot lines when building on specified town or city lots.

When using a steel tape do not leave it laying extended when not in use as stepping on the blade could snap it in two.

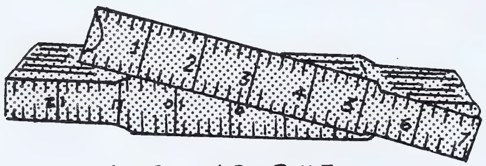


One additional procedure that the push pull rule or steel tape can be used for is to check the squareness of a rectangular area (see the diagram on the left). Given that the distances a = b and c = d, measure from corner to corner diagonally. When x = y all the corners should be square (90°).

3. Folding rules

(a) Zig Zag rule

Zig zag rule are more commonly used by bricklayers and block layers than by carpenters. They are still used by some carpenters but are not very common.



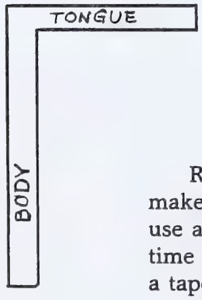
ZIG ZAG RULE

(b) Four-fold rules

Although some carpenters still use four-fold rules today they have been largely replaced by push pull rules.

4. Framing square (rafter square, steel square)

The framing square is one of the carpenters most useful layout tools. It can be used for squaring medium sized pieces of material and for squaring joints. [It does not work well for squaring large sections such as forms for garage pads or wall sections --(see steel tape section for method used).] The framing square can also be used for making short measurements.



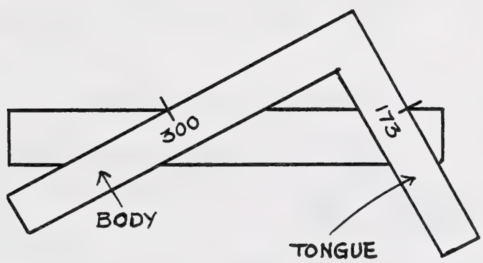
The body of a framing square is 600 mm long by 50 mm wide while the tongue is 400 mm long by 38 mm wide.

Remember it is not as accurate to mark out several short measurements as it is to make one long measurement. For example, if you wanted to measure 6 m you could use a framing square and take 10 lengths of the square but if you were out 1 mm each time your total error could be 10 mm. If you do the same job by measuring once with a tape your total error would be 1 mm.

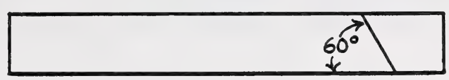
Another use for the framing square is to layout angles. Below is the procedure for drawing 60° angles.

(a) Place the square on the board as shown.

(b) Line up the 300 mm mark on the body and the 173 mm mark on the tongue with the same edge of the board. The tongue will now be at a 60° angle to the edge of the board.



(c) The completed line



We can use this procedure for various other angles which may be needed. The charts that follow give the necessary information

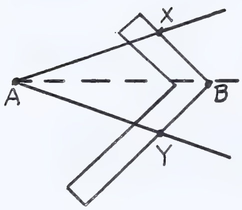
For the mitre angle, mark along the tongue:

Name	Number of Sides	Body	Tongue
Pentagon	5	305 mm	222 mm
Hexagon	6	305 mm	176 mm
Septagon	7	305 mm	146 mm
Octagon	8	305 mm	127 mm

For angles in degrees; mark on the tongue:

Angle	Body	Tongue
30°	173 mm	300 mm
45°	300 mm	300 mm
54°	300 mm	218 mm
60°	300 mm	173 mm
67.5°	300 mm	123 mm

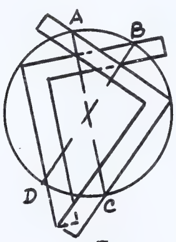
Angle	Body	Tongue
70°	300 mm	109 mm
72°	300 mm	97 mm
75°	300 mm	80 mm
80°	300 mm	63 mm



The framing square can be used for other jobs as well. Below are some examples.

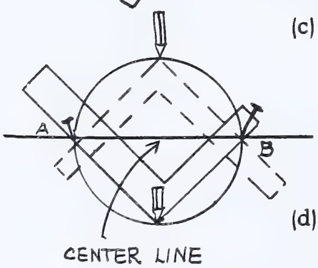
(a) Bisecting an angle

Locate the framing square so that x and y are the same number on the tongue and body. Join points A and B. This will make a line that bisects the angle. Distance Ax and Ay must be equal if the procedure was correctly done.



(b) Finding the Centre of a Circle

Numbers on the tongue and body (ie at A and C or B and D) must be equal where they intersect the circle.

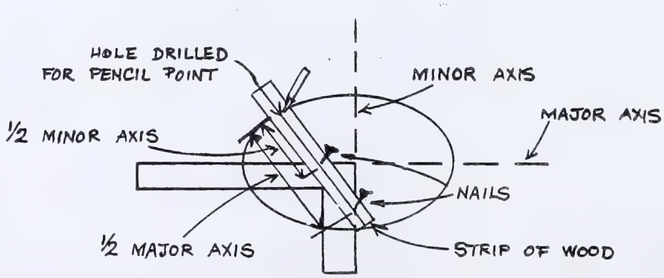


(c) Drawing a Circle

Nails are placed at points A and B. The pencil is placed at the corner of the square and it is slid along the nails. When one half of the circle is drawn the square is reversed to do the other half.

(d) Drawing an Ellipse

A piece of wood is prepared with a hole in one end for a pencil. Two nails are driven into the board in the positions shown. The square is placed on the project and the nails are slid along the square as the pencil marks the ellipse. This procedure must be followed for each quarter of the elipse.

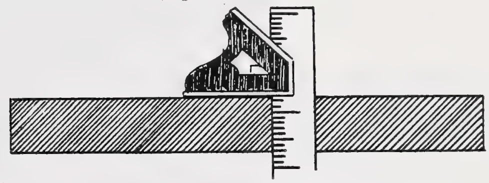


Framing squares are made of either aluminum or steel. If steel they are sometimes finished in copper or are blued to prevent rusting. If they are stainless steel or aluminum they are corrosion resistant.

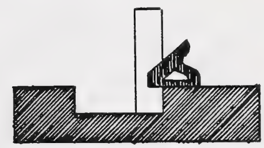
5. Combination Square

The combination square is another tool with a variety of uses.

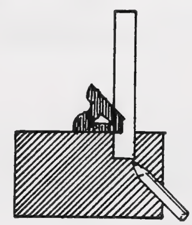
(a) It can be used to mark material for a 90° cut. (square).



(b) It can be used as a depth gauge.



(c) It can be used as a marking gauge. A pencil is held at the end of the blade as the head is slid down the edge of the board.



(d) It can be used to mark mitres (45°).

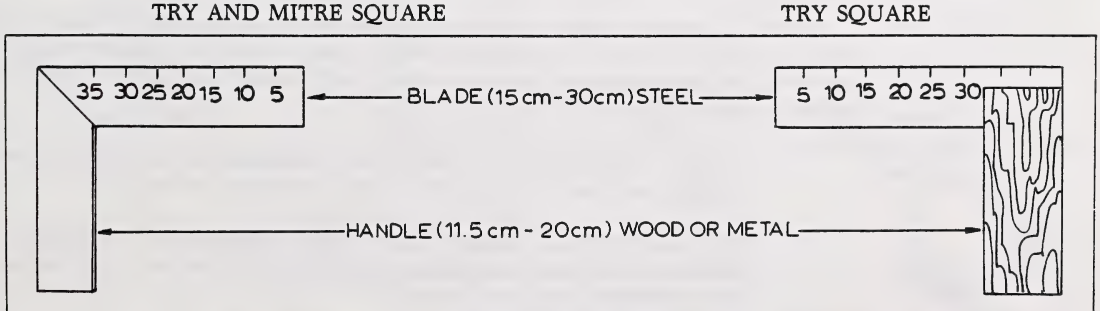
(e) It can also be used as a steel rule and to make short measurements.

(f) Although there is a level in the head of the combination square it is not reliable for leveling long distances. It could be used to level up to 20 cm long material.

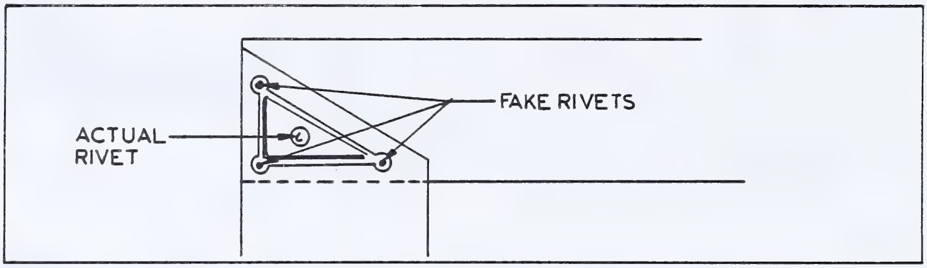
6. Try Square

Try squares are used for checking squareness and laying out 90° angles. They are not quite as handy as the combination square for use as a depth gauge or marking gauge because the head does not slide on the blade. However they are much more accurate and retain their accuracy much longer (especially the steel handled try squares) than combination squares. Combination squares have a head which slides on the blade and wear will decrease accuracy.

TRY AND MITRE SQUARE TRY SQUARE

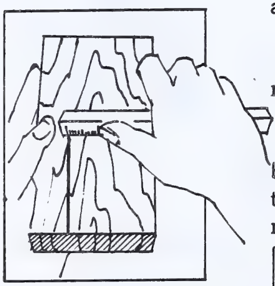


The Try and Mitre square is very useful for marking 90° and 45° angles (such as door and window casing; other trim) where accuracy is necessary. When buying one make sure to buy the all-metal type capable of marking both 45° and 90° and actually having three rivets holding the blade to the handle. Some try squares look like they have three rivets, but in reality, have only one which allows the joint to become loose quickly. See diagram below.



Some carpenters carry a combination square or a try square in their nail apron, as they find these tools are handy for squaring lines on boards. They are easier to carry around than a framing square although they are not as accurate.

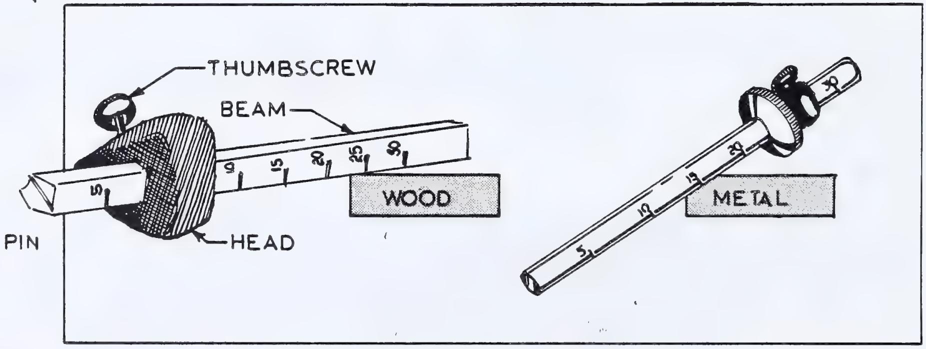
7. Marking Gauge



These tools are designed to gauge (mark) a line parallel to the edge or face of a board. They will work on a board up to 15 cm wide.

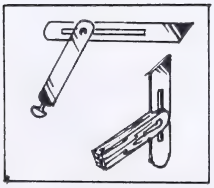
To insure accuracy, the setting of a marking gauge is usually checked with a ruler before gauging lines.

The proper way to hold a marking gauge is shown on the left. The pin should be tipped back (otherwise it will dig in). The marking gauge should not be allowed to rock. This means that the head and the pin have to travel forward at the same rate.



8. Sliding T-Bevel

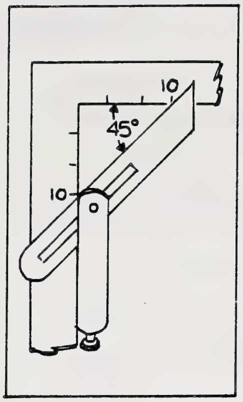
Sliding T-Bevels are used in a manner similar to try squares except that the blade is adjustable and may be set to any desired angle (with the aid of a plastic triangle, protractor, or framing square, or to an existing angle which you want to match). There are two types of T-Bevel:



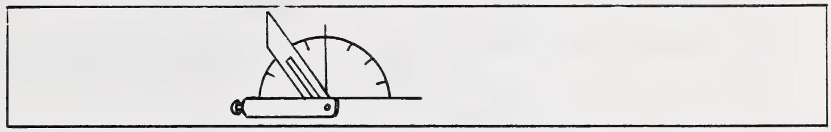
(a) the type shown at the left is of all-metal construction with the thumbscrew at the bottom end of the handle. This is the better to the two.

(b) The other type has a wooden handle and thumbscrew at the top of the handle (where the handle and blade join). In this position the thumbscrew often interferes with layout work.

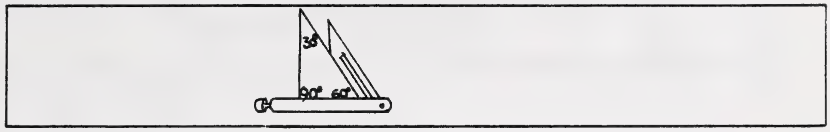
Sliding T-bevels can be set to the proper angle by a variety of methods.



(a) a sliding T-bevel can be set to the proper angle using a protractor.



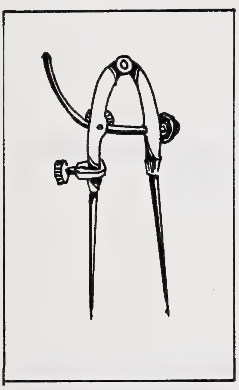
(b) a sliding T-bevel can be adjusted to 30° and 60° angles using a set square.



(c) a sliding T-bevel can be set to a 45° angle with the aid of a framing square. Note: anytime you draw a line joining the same numbers along the inside blades of a framing square this line will be at 45°. You could use the numbers 4 and 4 or 15 and 15 or any other similar combinations.

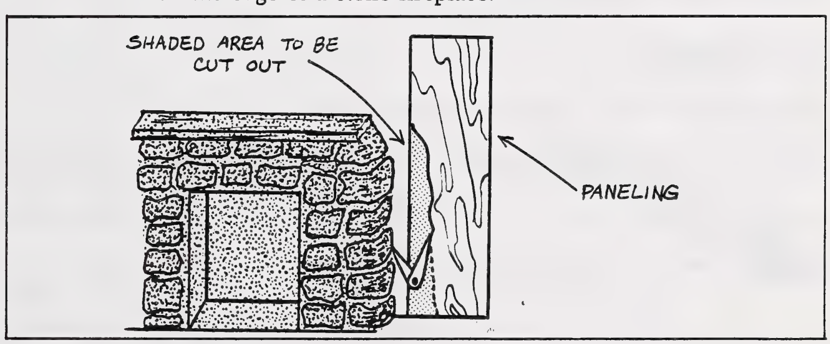
Once the sliding T-bevel has been set, the measured angle can be tranferred to any piece of material and marked with a sharp pencil or a marking knife.

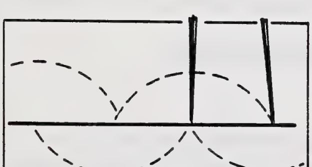
9. Wing Dividers, Scribers, and Trammel Points



(a) Wing dividers are used to lay out curves and circles and to "scribe" irregular lines on a board to match an irregular surface. They scratch a permanent line into the material. The following are the three common uses of wing dividers in building construction.

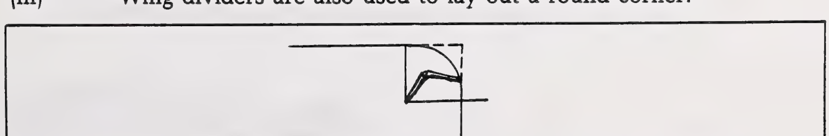
(i) Wing dividers can be used to scribe an irregular line on panelling to match the edge of a stone fireplace.

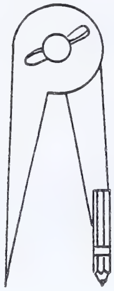




(ii) Wing dividers can be used to "step off" several equal spaces.

(iii) Wing dividers are also used to lay out a round corner.

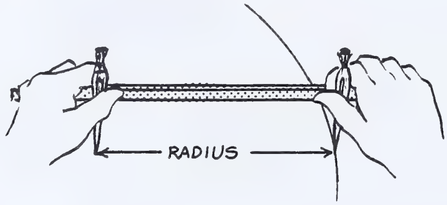




(b) A scriber resembles a compass in appearance. However the scriber has a blunt point, which does not mar the working surface where as a compass has a sharp point designed to protrude into the work.

A scriber is used to do the same type of work as dividers. The scriber has one metal and one pencil point and leaves a more definite line than dividers.

(c) Trammel heads consist of two metal points which are clamped to a wooden beam and used as large dividers.



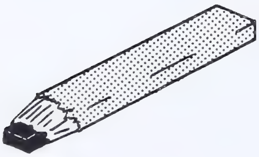
If a pencil is added in place of one of the points, we have the equivalent of a large compass.

10. Scratch awl

A scratch awl (or awl) is used to scribe (scratch) lines and to make holes in wood for a drill bit to start correctly without wandering from the drilling point.

11. Pencils

Pencils for layout are of two types.



(a) The carpenters pencil should be soft, coarse and dark for layout in framing. As the lead is rectangular and is drawn forward as shown to the left there is little chance of the lead breaking. This pencil is not suitable for fine work.

(b) The standard pencil sharpened to a fine point should be used for layout of finer materials. HB pencils are most common although harder 2H, 3H or 4H pencils make a finer line.

12. Utility Knife

Utility knives can be used for fine layout work where great accuracy and close fitting is desired. It should be used for jobs such as marking out hinges and door butts, etc. where a very tight fit is required.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. Give two reasons why the measuring tape is the most common measuring device used by carpenters?

   (a) ______________________________

   (b) ______________________________

2. When doing inside measurements between two objects with a tape measure, why do you have to add the length of the case?

   ____

   ____

   ____

3. Explain what will happen if you allow a push pull rule to race back into the case.

   ____

   ____

   ____

4. Why is it better to use a 30 m steel tape to measure an 85 m length than to use several measurements with a 5 m push-pull tape?

   ____

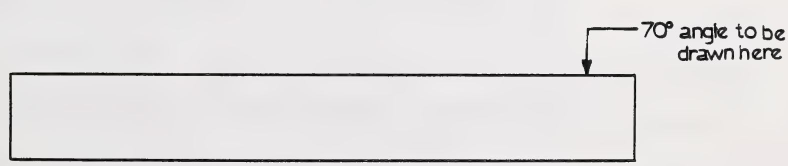
   ____

   ____

5. (a) Which two numbers, on a framing square, do you use to lay out a 70° angle?

   ______________ and ______________

   (b) Sketch the position of the framing square and the numbers selected on the work below. Show where you would mark the 70° angle.



6. Which two tools can be used to mark a line parallel to the edge of a piece of material?

   (a) ______________________________

   (b) ______________________________

7. Which one of the tools listed in question 6 will do the most accurate job?

   ____

8. Why is the level in the head of a combination square not used very often?

   ____

   ____

   ____

9. Explain the difference between a try square and a try and mitre square.

   ____

   ____

   ____

10. Why is a try square not considered as accurate as a framing square for squaring materials?

    ____

    ____

    ____

11. Why is it necessary to make sure that the pin and the head of a marking gauge move forward at the same speed?

    ____

    ____

    ____

12. What is the best tool to use to set the sliding T-bevel to an angle of 63°?

    ____

13. Describe the type of work that a sliding T-bevel would be used for.

    ____

    ____

    ____

14. Which four tools listed in Lesson 1 could be used to draw a circle?

(a) ______________________ (c) ______________________

(b) ______________________ (d) ______________________

15. Which of the tools discussed in the lesson make it possible for a bit to start drilling correctly without wandering?

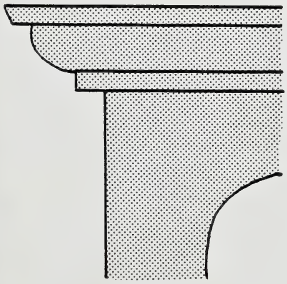
16. Which type of pencil would a carpenter likely choose to mark the length of his framing lumber?

17. Why is the try square more accurate than a combination square?

EXERCISE 2

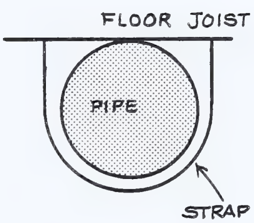
1. Utility knives are used for fine layout work, instead of a pencil. Why is a utility knife better for marking material for a cut when a very tight fit is required?

2. I want to fit a wall panel against the edge of a decorated fire place. How can I mark the correct curve? Also explain where you would place the plywood as you mark it.



3. Suppose you nailed together a wall section. Before sheeting you wanted to check it for squareness. How would you do this? Which tools would you use for the job?

4. Suppose you had to hang a pipe and you had to cut a peice of strap to fit. How would you measure for the correct length of strap?



END OF LESSON 1

Questionnaire for Building Construction 12

Please fill this in and send it with your first lesson.

NAME ______________________ FILE NO. ______________

ADDRESS ______________________ PHONE NO. ______________

____

POSTAL CODE ______________________ AGE ______________

Welcome to Building Construction 12, we hope that you will enjoy this course and find it informative and useful. Please complete the following, as this information will help your teacher when writing to you as an individual.

1. Why are you taking this course? ______________________

2. What do you already know about Building Construction? ______________________

3. What kind of tools and work space do you have available for practical work? ______________________

4. How good are you with Math? If you have difficulties, please state what they are, and also what Math courses you have taken and what marks you have obtained.

5. What do you know about the subject of study? Do you have any difficulty studying? If so, what problems do you have with studying?

6. Is there anything you would like to say before starting this course?

A PERSONAL GUIDE FOR LESSON COMPLETION IN BUILDING CONSTRUCTION 12

Below you will find a procedure for calculating the frequency with which you must submit lessons in the Building Construction 12 course to finish by the date you have chosen. Use it as a guide in working on your lessons and try to follow it as closely as possible. If you do, your lessons will not stack up at the end, either for you or for the teachers at the Alberta Correspondence School.

Study the example given below and complete pages (ii) and (iii) accordingly.

Example: Suppose it is October 20, you have 12 lessons yet to do and you wish to finish by January 6.

$$\text{No. of days remaining} = \underset{\text{Oct.}}{(31 - 20)} + \underset{\text{Nov.}}{30} + \underset{\text{Dec.}}{31} + \underset{\text{Jan.}}{6} = 78 \text{ days}$$

$$\frac{\text{No. of days}}{\text{No. of lessons remaining}} = \frac{78 \text{ days}}{12 \text{ lessons}} = 6.5 \ \frac{\text{days}}{\text{lesson}}$$

You have approximately 6 days to do each lesson.

Lesson	To Be Completed By
Today's Date	October 20
1	October 26 (add 6 to 20)
2	November 1 (add 6 to 26)
3	November 7
etc.	etc.
12	December 31

Note that since you rounded off 6.5 days to 6 days you will be finishing early. But this is much better than finishing too late by using $7 \ \frac{\text{days}}{\text{lesson}}$.

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

____

(If label is missing
or incorrect)

File Number

____

Lesson Number ____________

Student's Questions and Comments

Apply Lesson Label Here

Name ____________
Address ____________
____
____
Postal Code ____________

Please verify that preprinted label is for correct course and lesson.

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received:

____

Lesson Recorded ______

Teacher's Comments:

____
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

SURFACING TOOLS

Bench planes
Block planes
Wood chisels
Scrapers
Forming tools

INTRODUCTION

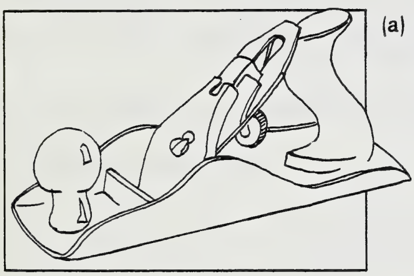
A person has to carry out a wide variety of tasks if they are going to become a competent, qualified and respected tradesman. Their knowledge of and skill in the use of hand tools will greatly aid versatility and therefore the opportunity for full-time employment

The use of hand tools should not be a struggle. The correct tool, in good condition and used properly, makes the work easier and helps in turning out a better than "acceptable job".

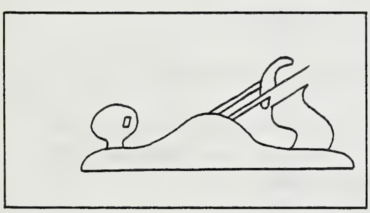
BENCH PLANES

1. Types of Bench Planes

There are four different types of bench planes. The main difference between the four types is in their length (in the longer ones the plane iron may be wider as well).



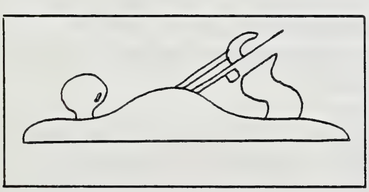
(a) The smooth plane is the smallest of the bench planes with a length of 203 mm and a cutter width of 44 mm or a length of 229 mm with a cutter width of 51 mm. 51 mm is the most common width of cutter. The smooth plane is used for planing work approximately 200 to 400 mm long. On longer surfaces smooth planes do not tend to make the worked surface straight.



(b) The jack plane is 356 mm long and has a cutter width of 51 mm.

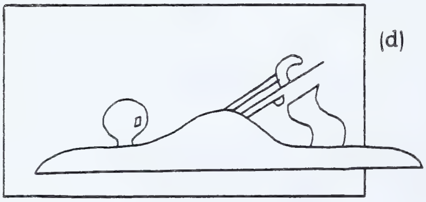
The jack plane is the most versatile and widely used plane. Because of its average size in the plane family, it can take the place of any other bench plane. However it is less accurate than the longer planes on large work and more clumsy to use on small work than the smaller plane.

The jack plane works well on material from approximately 300 mm to 700 mm. It is used for planing when fitting siding, casing, etc.



(c) Fore planes have a length of 460 mm and a cutter width of 600 mm.

They are not commonly found on jobs today because they are halfway in length between the jack plane and the jointer plane. They are neither as accurate as the jointer nor as light and compact as the jack. If you want a long plane for making straight-edges or planing door edges, the jointer is the one to buy.



(d) The jointer plane is 560 mm long and has a cutter width of 60 mm.

The jointer plane is the longest of the hand planes. It is a useful tool for planing a true edge on doors, windows, etc. They are rarely found and are not commonly used by most carpenters.

2. Disassembling and Assembling of Bench Planes

NOTE: In order to understand the following most easily, get a plane and have it in front of you as you are studying. Also you can place chart #9 (page 18) in front of you for easy reference.

Study the parts of the plane on chart #9 page 18. Although the frame shown on the chart is a smooth plane, the working parts are the same for the jack, fore, and jointer planes. Study chart #13 page 19 adjustment of the jack plane. Practice using the lateral adjustment lever until you can easily set the cutting edge square with the plane bottom and practice using the depth adjustment next until you can see a very fine line of the plane iron showing below the surface of the plane bottom.

The parts you must know are parts #1, 2, 3, 4, and 5 on page 18, as well as the two adjustments explained above.

To remove the plane iron:

(a) Take the plane in your left hand, bottom down, with the toe of the plane facing left.

(b) Raise the cam of the lever cap. It should move smoothly and easily.

(c) Gently raise the lever cap out of the plane and set it on a sawhorse or bench.

(d) Next, gently raise the double iron out of the plane (carefully; do not bump the cutting edge of the plane iron against the plane -- it will nick and dull the edge). Set the plane body down on the bench (always on it's side).

(e) Place the double plane iron in the palm of your left hand (cap iron screw up) and, taking the lever cap in your right hand, place the centre of the lever cap in the center of the cap iron screw and turn left (counterclockwise). Do not use the corner of the lever cap because it will break off under excessive pressure. Do not turn the screw all the way out -- just loosen slightly.

(f) Slide the plane iron forward on the cap iron so that the cutting edge of the plane iron does not touch the cap iron. Swing the plane iron sidewise. Then slide it forward until the large, round part of the slot lines up with the cap iron screw. Lift off the plane iron and set it down on the bench with the sharp part of the bevel up.

To assemble a plane iron:

Reverse the procedure for removing the plane iron and read chart #12 (page 20).

The plane iron should project past the cap iron almost 2 mm for general planing purposes. For coarse planing, project the plane iron further, and for fine planing, especially on hardwood, reduce the amount of projection. Don't try to jam the cap iron screw as hard as possible. Make it snug enough so that the two irons do not slide on each other.

(a) Again, be careful that the cutting edge does not strike against the plane.

(b) Look at the plane from the side to be sure that the plane iron is flat and tight to the frog. If it does not appear to be, slide it around until the cap iron screw fits into the proper slot in the frog and also that the lower end of the lateral adjusting lever fits into the slot in the plane iron. If the plane iron does not fit snugly to the frog then the cap iron will not fit back on the plane. The tendency for most beginners is to loosen the lever cap screw. Do not do this until you have checked to see if the plane iron is fitting properly.

(c) Slide the lever cap back on over the cap iron screw, hold the plane in one hand with your thumb on the cam of the lever cap, and squeeze down (don't use both hands). If the pressure is too great to allow you to do this, loosen the lever cap screw (only 1/8 of a turn each time) until the lever cap fits as described. If the plane iron is too loose, tighten the lever cap screw 1/8 of a turn each time until the fit is snug.

(d) Again read chart #13 (page 19) which show you how to properly adjust the plane. Remember two points: a plane will move easily through the work if it is, (a) sharp and (b) set fine. A dull plane with the plane iron exposed too far will cause you to work hard, will jump or "chatter" across the work, and will do a very poor job.

3. Using Bench Planes

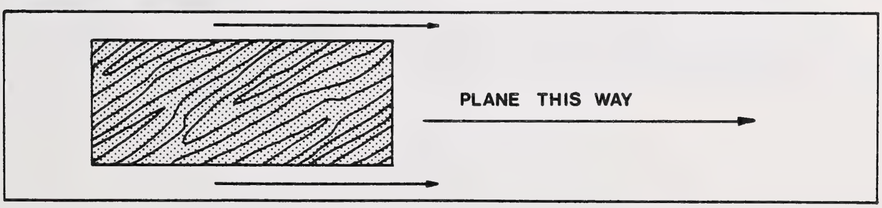
To learn how to properly use a jack plane, study chart #14 (page 21).

(a) The plane iron must be set fine.

(b) As the chart shows, keep the pressure on the toe of the plane as you start and on the heel of the plane as you finish If you allow the plane to rock, you will make a crowned edge, as noted to the left. This crown can be removed by planing with short strokes which start inward from the starting end and stop short of the other end.

(c) If the plane pushes too hard, the plane should be set for a finer cut. Remember that you should not have to struggle with the plane. Normally the plane will make a paper thin shaving which will curl up.

(d) Plane with the grain. If you plane against the grain the lumber will be torn or rough. To plane with the grain means the plane must move in the same direction the wood fibres are running when they come to the surface.



(e) Plane down just to your layout lines If you plane the lines off, you won't be able to tell if you've done a straight job.

(f) Follow the six steps for planing a board to size. Do not go on to the working edge until the working face is done, etc.

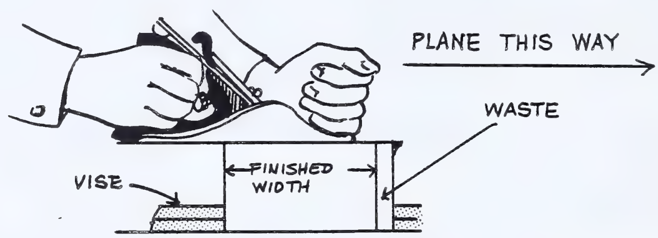
(g) Check for warp in the board by setting a straight-edge, such as a framing square or level, across the board, length-wise on the board, and diagonally corner to corner. Mark high spots with a pencil and plane these off until the board is flat and straight.

(h) Be careful when planing across the end (end grain) of a board (see chart). Practice on a scrap piece.

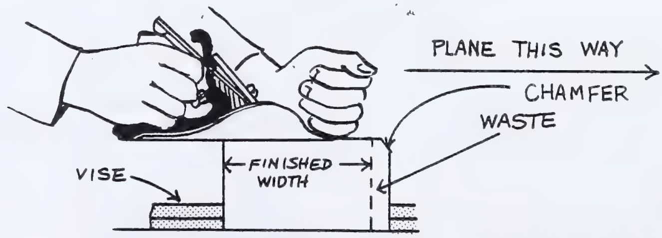
There are three methods of preventing splitting when planing end grain.

(i) plane from both edges to the middle. (see the chart on page 21.)

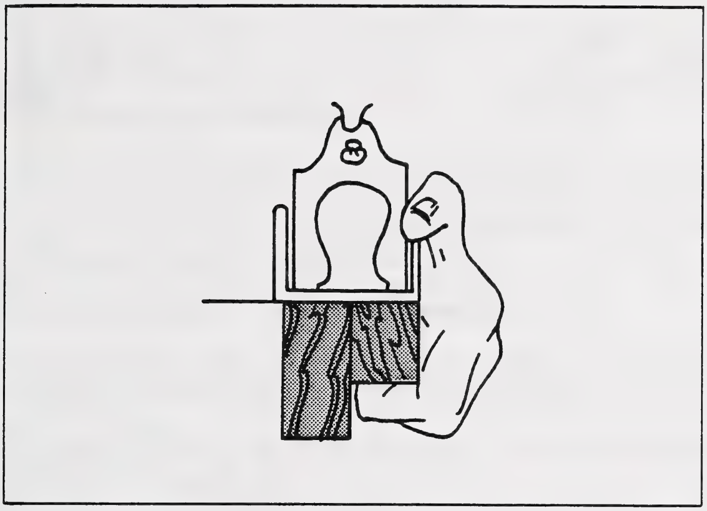
(ii) clamp a scrap piece of material to the far edge of your material and then plane across the good material and the waste.



(iii) Chamfer far edge. The chamfered corner will prevent splitting as the plane leaves the end. Note -- the board has to be wide enough so that the chamfer is in the waste stock.



(i) To plane a narrow edge, grip a square tip of wood tightly to the bottom of the plane.



The jack, jointer, fore, and smooth planes are manufactured with both smooth bottoms and corrugated bottoms. Some carpenters believe that planes with corrugated bottoms offer less resistance when pushed across a wood surface but it is doubtful if the difference between the two could be measured without sophisticated measuring devices.

The adjustments and maintenance are similar for these four planes. The size of the mouth can be changed by adjusting the frog (refer to chart #9, page 18); for general planing, the size of the mouth need not be changed, but for continual fine planing of hardwood, the mouth could be made smaller, and for softwood, the mouth could be larger (will not plug as easily).

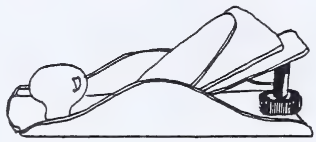
BLOCK PLANES

1. Types of Block Planes

The next important plane to a carpenter, especially if he or she is involved in finishing work, is the block plane. The block plane is ideal for planing end grain of wood and where one hand must be used to hold the material. Most manufacturers have three basic styles of block planes.

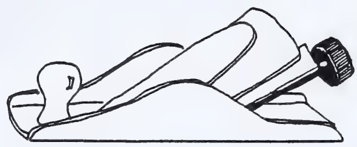
(a) The number of 9½ block plane.

This plane is 150 mm long with a plane iron 41 mm wide. The plane iron is placed in the plane at a 21° angle.



(b) The number 65 block plane.

This plane is 180 mm long and has a cutter 41 mm wide. The plane iron of the number 65 block plane is placed at 12° angle -- much lower than the number 9½ block plane.



(c) The number 60½ block plane.

It is 150 mm long with a plane iron 35 mm wide.

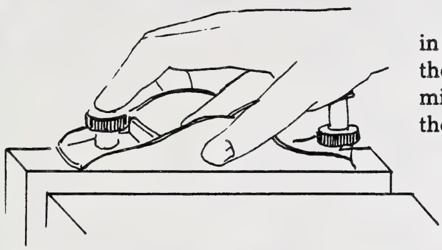
The major difference between these different types of block planes is the angle of the plane iron as it sits in the plane. The 9½ plane has an angle of 21° whereas the 60½ and the 65 have a lower angle of 12° on the plane iron.

The lower angle of the plane iron makes the plane easier to push. However the plane iron will not stay sharp as long as in a plane with a greater angle.

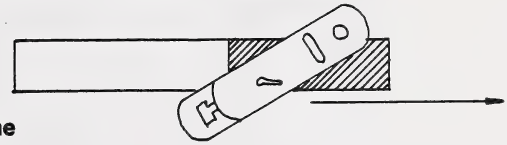
For the carpenter who will be carrying a block plane in a back pocket while installing door and window casings, siding or other finishing where a close fit is required, the number 60½ would be the best as it is smaller and pushes easily.

Again, a sharp plane, set fine, works best!

2. How to Use a Block Plane



To use a block plane, grip it firmly with thumb and second finger in the depressions on each side of the plane and the index finger on the knob in front. For planing a short cross-section (such as the mitered angle on door casings) turn the plane iron. This also narrows the cutting width of the plane so it will push easier yet.



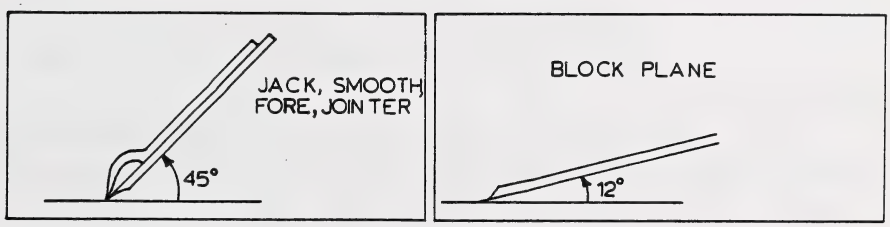
3. Differences Between a Block Plane and a Bench Plane

(a) The block plane does not have a plane iron cap where a bench plane does. The plane iron cap on the bench planes breaks and curles the shaving so it does not jam in the plane. The block plane does not require a plane iron cap because the beveled edge is upward and will curl the shaving.

(b) The block plane is smaller than the bench planes.

(c) The block plane has the plane iron placed in the plane at a lower angle. As with all cutting tools the flatter the angle of the cutter the easier it will be to push.

However, the plane iron does not stay sharp very long and must be resharpened more often.

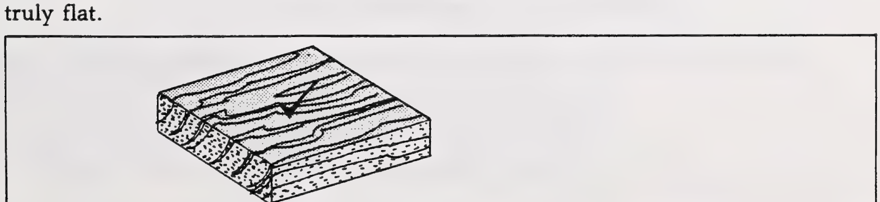


4. Job Sequence for Planing a Board

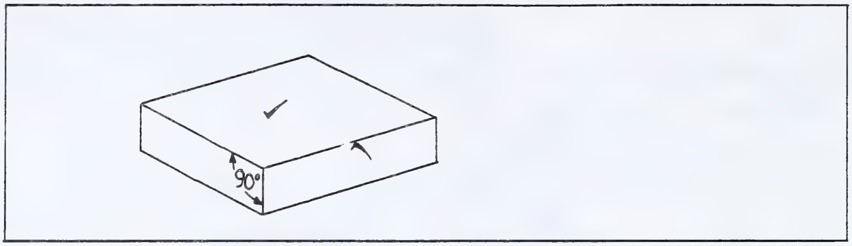
A haphazard approach to any job, whether it be building a house or a small project, drafting, estimating, or tuning up a car, is time consuming. It is likely to cause a worker to repeat parts of a job because one step was left out or performed out of sequence.

Let us look at a step-by-step approach to doing a job. The job will be to finish a block of wood to the correct length, width, and thickness. All the corners must be square and all the surfaces flat. The procedure in step form is given below. This procedure applies to bench planes as well as block planes

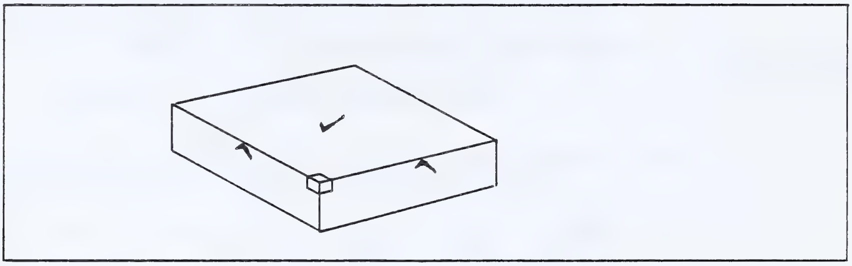
(a) Choose a working face. It should be the straighter, smoother, and cleaner face of the two. Plane it smooth and flat and, using some system, mark it clearly. Remember to check lengthwise, crosswise, and diagonally to ensure the surface is truly flat.



(b) Choose the better edge as a working edge and plane it until it is square to the working face. Remember it must be straight as well. Mark it clearly.

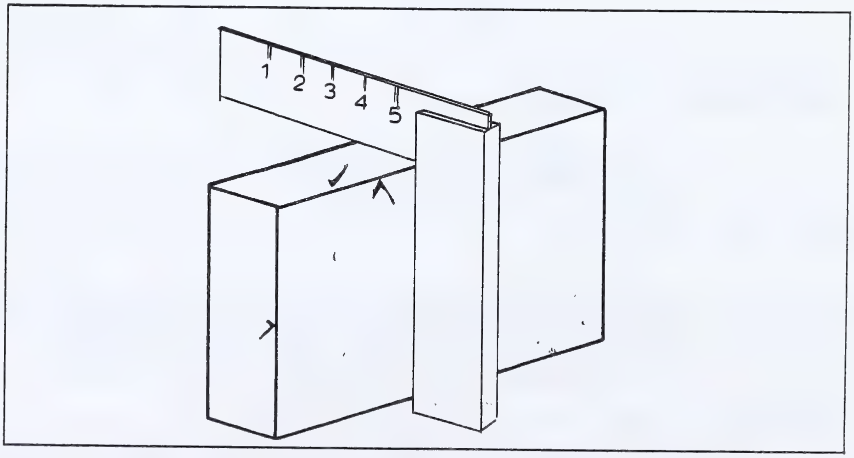


(c) Choose the better end as a working end, plane it square and smooth. Mark it clearly.



Now you have three square, straight, clean working surfaces from which to make all measurements and they are marked clearly so that you will make not make a mistake and measure from a surface which may not be straight or square.

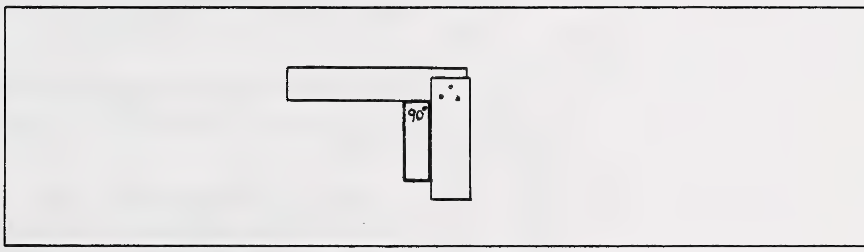
You can also use an e, or v, or something similar to indicate your working surfaces. Decide on one system and stick to it. A mark should be clear but not too fancy.



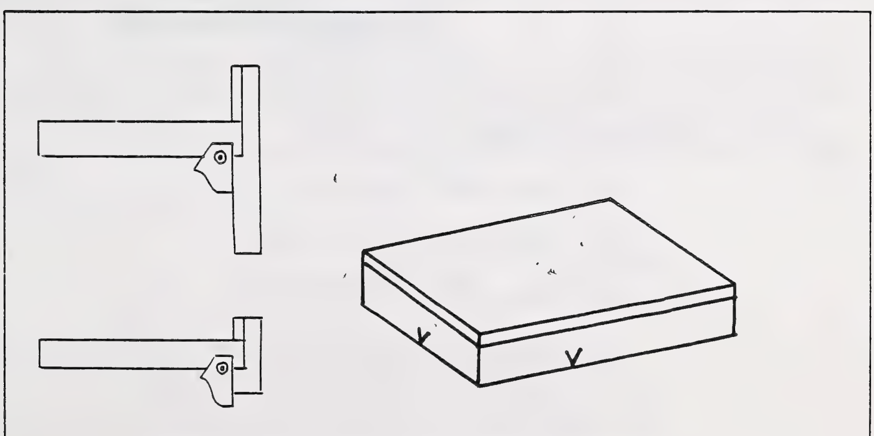
Steps (a), (b), and (c) should almost always be done in that sequence. Steps (d), (e), and (f) follow but may not always be done in this sequence for all jobs. Some projects require you to use a different sequence.

(d) Second End - measure the correct length from the working end and mark a square line across the face. Mark a square line across the working edge also, to guide you when you saw-off the end of the board. Saw carefully and plane smooth. Check for squareness by placing the handle of the square against the working face and then the working edge. Make sure the end is straight as well.

(e) Second Edge - using a marking gauge or combination square set to the proper distance, scribe a line on the board parallel to the working edge. Plane smooth and check that this edge is square to the working face and working end.



(f) Second Face - set the marking gauge or combination square to the desired thickness of the board. Hold the head of the square or marking gauge tight against the working face and scribe a line across both edges and both ends.



Plane the second face down to these lines. Check to make sure it is flat and square.

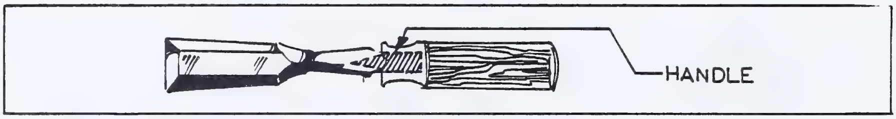
WOOD CHISELS

Wood chisels are used in every phase of construction from fine finishing through framing, to heavy construction. The type of chisel used depends on the job to be done.

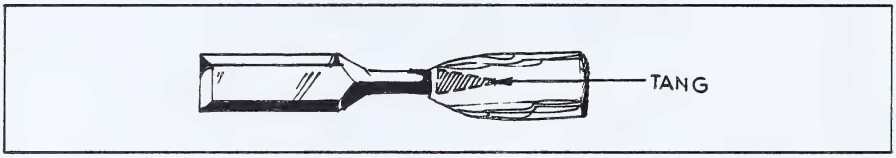
1. Chisels are classified in three ways.

(a) the way the handle and blade are joined.

(i) socket - the handle fits into a socket in the blade

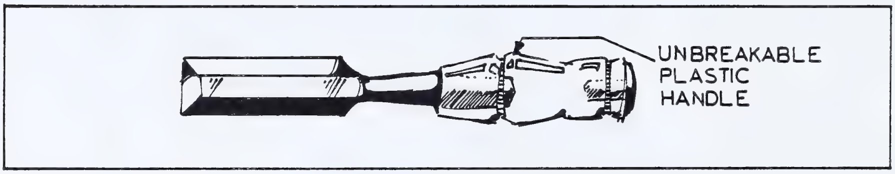


(ii) tang -- the tang on the blades fits up into the handle



The older type of tang chisels have a sharp, pointed tang that drives up into a wood handle (much like the tang on a file). A mallet should not be used with this type of chisel.

(iii) heavy duty -- specially made for heavy duty, rough work where a great deal of pounding is involved. Some of these have a steel blade continuous through the handle, others have a virtually unbreakable plastic handle, and some have a steel handle only.



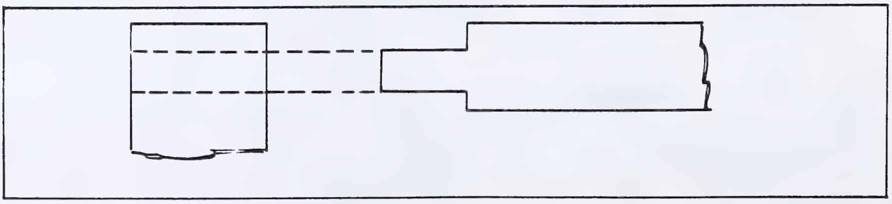
(b) By the length;

(i) butt -- blade 76 mm long

(ii) pocket -- blade 114 mm long

(iii) firmer -- blade 152 mm long

(iv) mortise -- long, heavy blade. This chisel is seldom used or seen anymore because deep mortises such as in the stile of a door would not be done by hand today but by a mortising machine.



The butt chisel is the most useful and easily held chisel for cutting accurately to a line (e.g. -- fitting door butts) because it is short and easy to hold to a line and strike with a mallet. The longer chisels are more difficult to hold on a line (sway back and forth) and are easier to miss with a mallet.

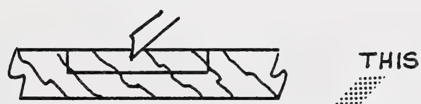
For general carpentry work the pocket or firmer chisels would be most useful. They are easier to hold with both hands for paring cuts and can reach deeper corners than the butt chisels.

(c) By their width

Chisels are ordered by their width. They range in width from 6 mm to 50 mm wide.

2. Working with a Wood Chisel

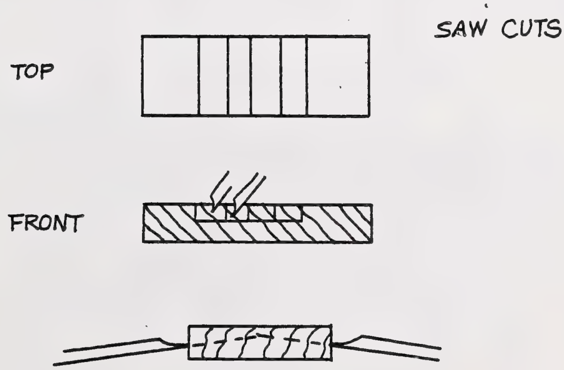
Work with, not against, the grain of wood with a chisel, as with a plane, otherwise you will end up with a chipped job.



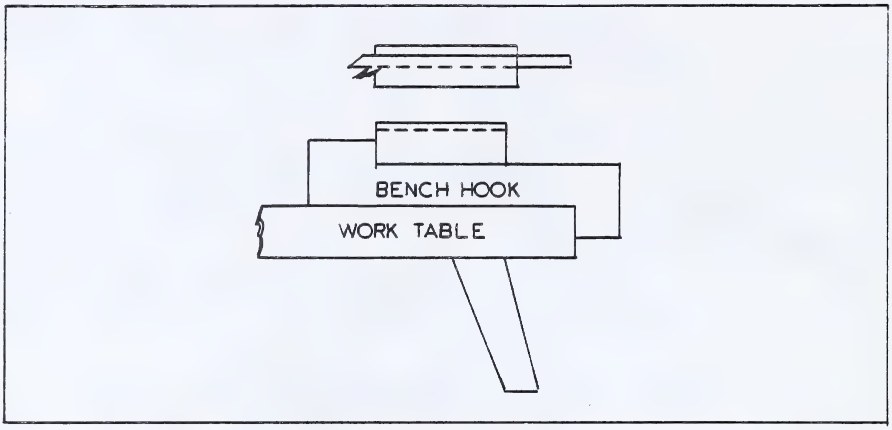
Wood has a tendency to split along the grain.

A mallet is generally used when extra force is required on a wood chisel. The mallet is softer than a hammer and does not damage the chisel. Some chisels, however, have heavy duty plastic handles. If your chisels are of this type you may use a claw hammer provided you do not hit them with heavy blows. The hard blows will nick or chip the plastic handle.

(a) to take out the middle piece of the block below, make several saw cuts down to the layout line, as shown. Using your chisel, take angle cuts as shown, with the grain, almost down to the layout line. Keep both hands on the chisel, making paring cuts as shown below. For greater accuracy, use the widest chisel that will work.

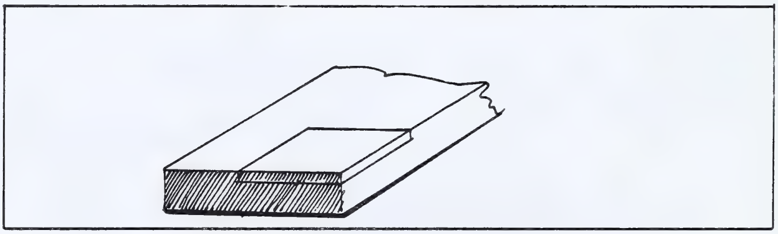


If you try to chisel straight across, the chisel may slip and tear the wood on the opposite side to you. The block should be set against some sort of stop block such as a bench hook so that it is held firmly and you can keep both hands on the chisel. If you hold the block with one hand the chisel is likely to slip and a severe cut could result.

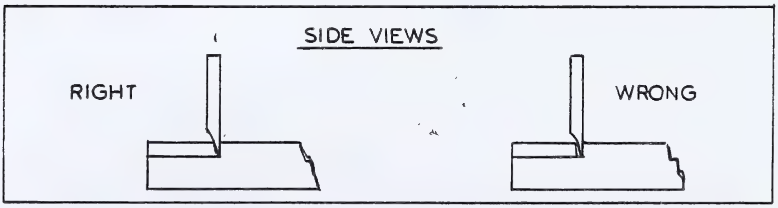


(b) To cut a gain (notch) in a piece of wood to receive a door butt or another piece of wood:

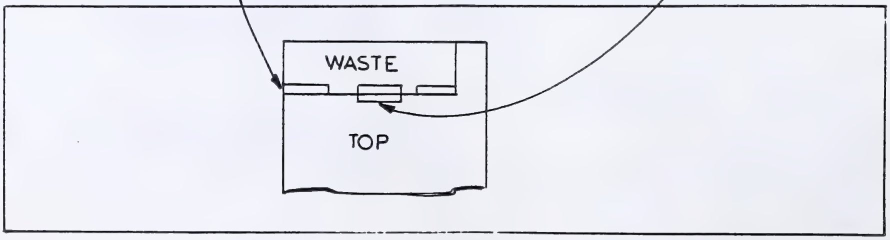
(i) lay out very carefully (length, width, and depth).



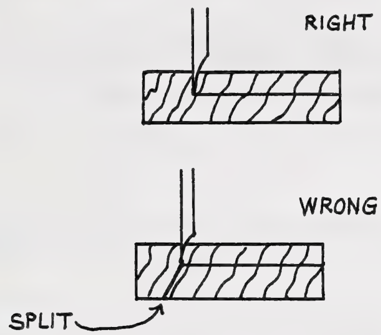
(ii) using your widest chisel that will work and a mallet, tap lightly and make a cut (about 2 mm deep) along the line across the grain; if you hit the chisel too hard it will move past your layout line (because the wedge shape of the chisel). Make sure you cut on the waste side of the line, otherwise the gain will be larger than your layout lines.



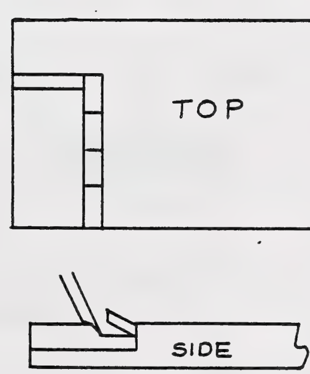
Tap lighly so the chisel stays on the waste side of the layout line. If hit hard the chisel will wedge past the line.



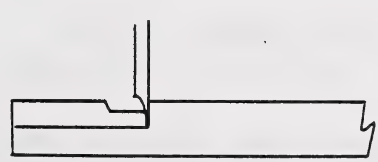
(iii) Do not use a mallet when cutting with the grain, especially when using softwoods, because it will split easily. Just push firmly with your hands.



(iv) Make several light cuts with the chisel (and mallet), about 6 mm from your layout line, so that small chips fall out as shown.

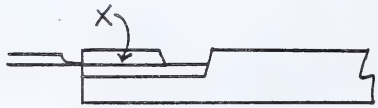


(v) Now you can cut deeper along the layout line without wedging past the line. Cut down almost to this layout line.

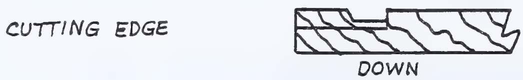


SIDE VIEWS

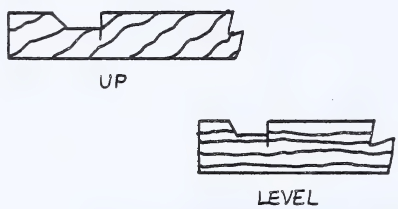
(vi) Turn the chisel as shown below and tap gently to break off small chips (x) of wood. Make the first chips thin ones until you determine whether the grain is breaking down, up, or level.



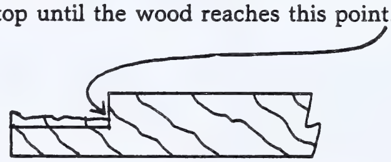
If you tap a chisel with the cutting edge at the point shown when the grain is breaking down you could easily split the wood past your layout line and ruin the work.



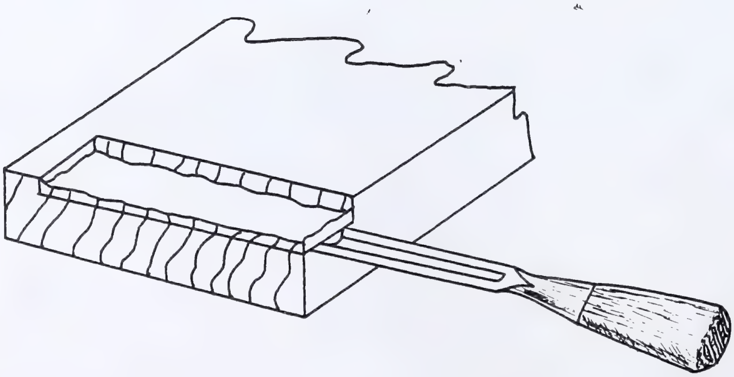
Less care is required if the grain is breaking upward or is level.



Take light cuts from the top until the wood reaches this point.



Then finish with paring cuts. Use paring cuts until the grain is square and flat. Study charts #17 and #18 (pages 22 and 23)



SCRAPERS

Where a fine smooth surface is required and where it is desirable to bring out the beauty of the wood, the wood surface should be scraped.

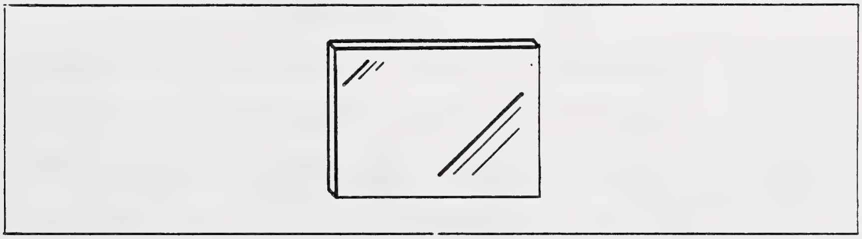
A scraper, when properly sharpened, will remove marks in cross grained or wavy grained wood that a hand plane would chip. They are also used for removing old paint and varnish. A light sanding with fine sandpaper may be necessary after scraping.

There are several types of scrapers as shown below:

1. Hand Scrapers

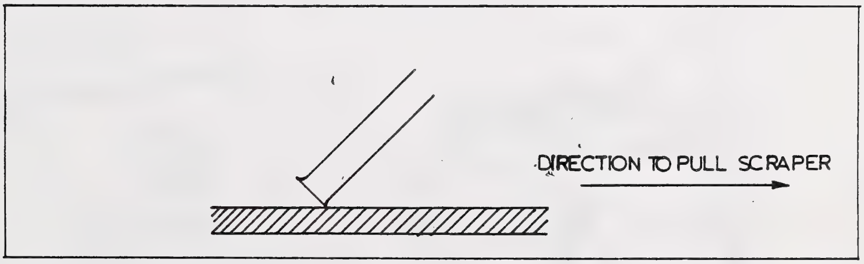
There are two types of hand scrapers. They are:

(a) Rectangular hand scraper. This scraper is used for flat smooth work.



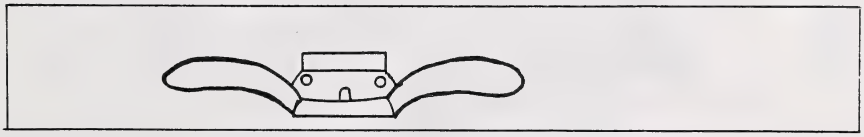
(b) Swan-neck hand scraper. This scraper is used for smoothing rounded or irregular work.

When using a rectangular or swan-neck scraper position the blade as shown below.



2. Cabinet Scraper

A cabinet scraper has a scraper blade mounted in a base. The blade is adjustable for depth. This allows you to keep the angle of the scaper as well as the depth constant.



3. Pull Scrapers

(a) Fixed handle pull scraper.

(b) adjustable handle pull scraper

A pull scraper can be used for scraping wood similar to the hand scraper.

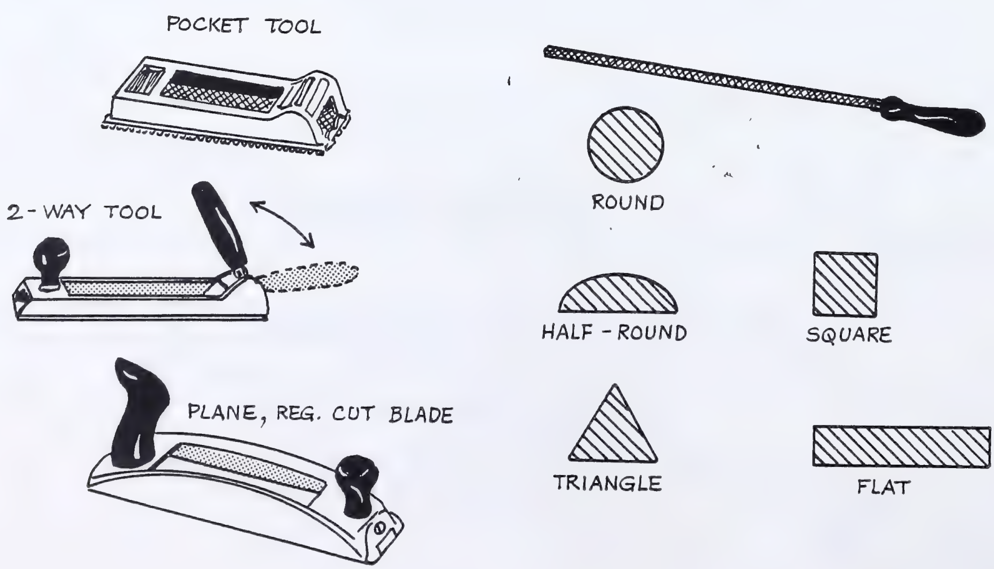
Depth of cut is controlled by varying the amount of pressure on the head.

If the angle of the head changes during the stroke, gouging can occur.

See charts #28 and #29 (pages 24 and 25) on how to use hand scrapers.

FORMING TOOLS

Forming tools ('Surform') are relatively recent additions to hand tools. They are serrated (offset cutting edges) blades which cannot be sharpened but simply replaced when worn. They are useful in forming irregular shapes and are particularly good tools for forming edges of plywood, plastics, hard board, tentest, and even soft metals. There are a variety of shapes available (jack plane, block plane, flat file, and round file). Look for new shapes in these hand tools. They are used like planes except there is no depth adjustment.The depth of cut depends upon the downward pressure you exert.



HOW TO WHET

STANLEY PLANE IRONS

(THIS ALSO APPLIES TO CHISELS)

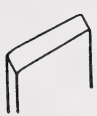
STANLEY

STANLEY

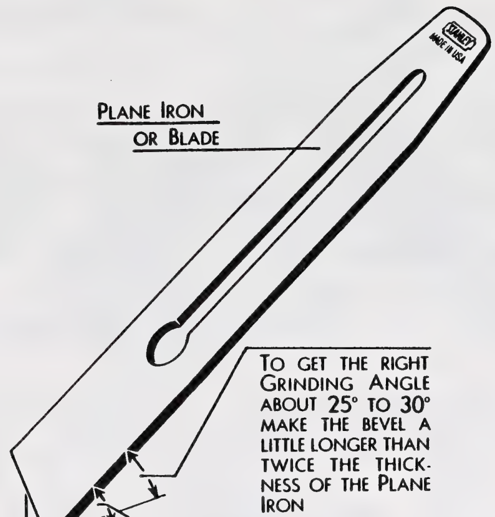
WHET THE PLANE IRON ON THE OIL STONE TO PRODUCE THE REAL SHARP CUTTING EDGE.
HOLD THE PLANE IRON IN THE RIGHT HAND WITH THE LEFT HAND HELPING.
PLACE THE BEVEL ON THE STONE WITH THE BACK EDGE SLIGHTLY RAISED.
MOVE THE PLANE IRON BACK AND FORTH.

TO KEEP THE BEVEL STRAIGHT

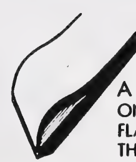
BE SURE THE HANDS MOVE PARALLEL TO THE STONE SO THAT THE ANGLE BETWEEN THE PLANE IRON AND THE STONE WILL STAY THE SAME THROUGHOUT THE STROKE.
USE ENOUGH OIL TO KEEP THE SURFACE OF THE STONE MOIST. IT KEEPS THE STONE SHARP BY PREVENTING PARTICLES OF STEEL FILLING THE PORES OF THE STONE.
TRY TO WEAR THE STONE EVENLY.



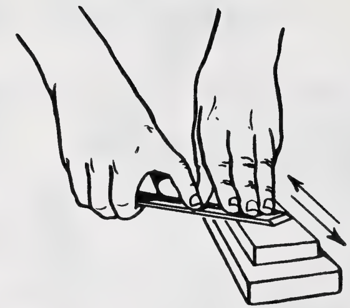
PLANE MARKS WILL SHOW LESS ON A FINISHED SURFACE IF THE CORNERS OF THE PLANE IRON ARE SLIGHTLY ROUNDED.



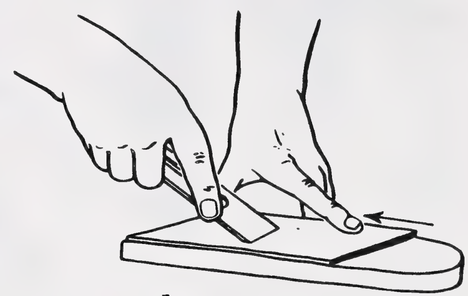
ROCKING THE PLANE IRON PRODUCES A ROUND BEVEL THAT WILL NOT CUT WELL.



A BEVEL ON THE FLAT SIDE OF THE PLANE IRON PREVENTS THE CAP IRON FITTING TIGHT, SHAVINGS WILL CLOG THE PLANE.



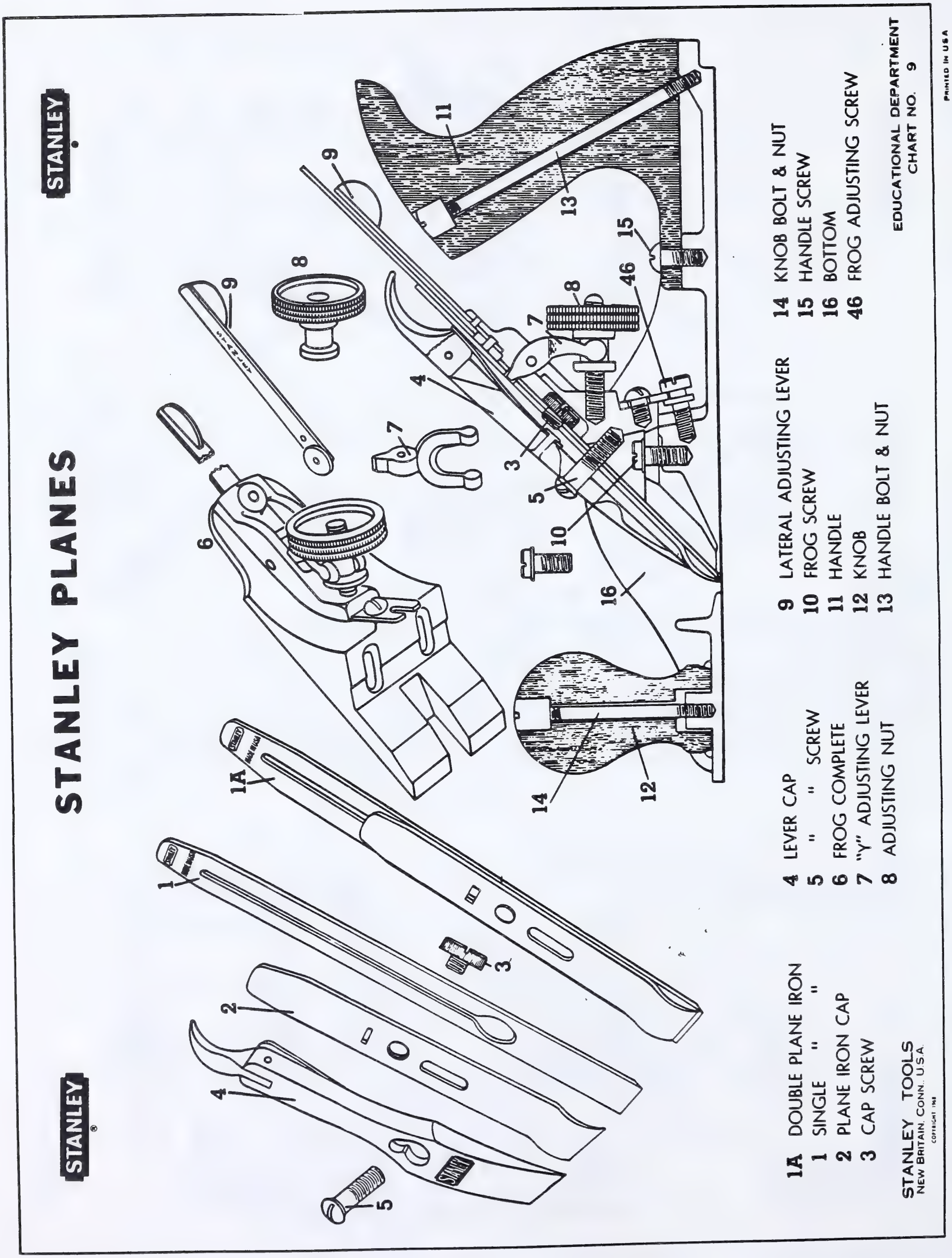
REMOVE THE WIRE OR FEATHER EDGE BY TAKING A FEW STROKES WITH THE FLAT SIDE OF THE PLANE IRON HELD FLAT ON THE STONE. AVOID THE SLIGHTEST BEVEL ON THIS SIDE.
IF A NICK OR A SHINY EDGE OF BLUNTNESS CAN BE SEEN, REPEAT BOTH PROCESSES OF WHETTING.



FINISH WITH A FEW STROKES ON A LEATHER STROP TO PRODUCE A KEENER EDGE.

STANLEY TOOLS
NEW BRITAIN, CONN., U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 11
BY R O REGER

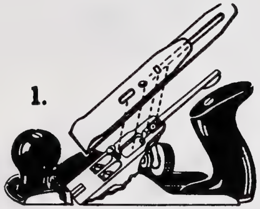

STANLEY
STANLEY PLANES
STANLEY
1A DOUBLE PLANE IRON
1 SINGLE " "
2 PLANE IRON CAP
3 CAP SCREW
4 LEVER CAP
5 " " SCREW
6 FROG COMPLETE
7 "Y" ADJUSTING LEVER
8 ADJUSTING NUT
9 LATERAL ADJUSTING LEVER
10 FROG SCREW
11 HANDLE
12 KNOB
13 HANDLE BOLT & NUT
14 KNOB BOLT & NUT
15 HANDLE SCREW
16 BOTTOM
46 FROG ADJUSTING SCREW
STANLEY TOOLS
NEW BRITAIN, CONN. U.S.A.
EDUCATIONAL DEPARTMENT
CHART NO. 9
PRINTED IN USA

STANLEY

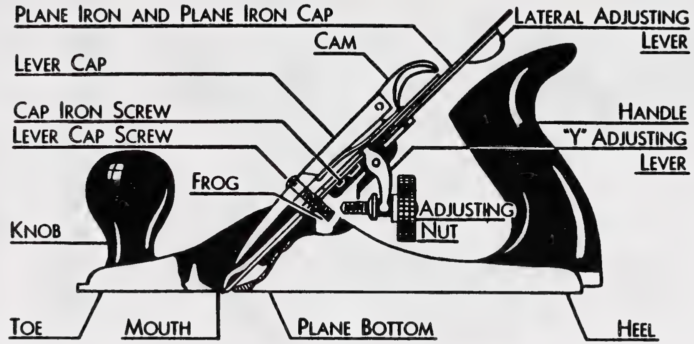
HOW TO SET THE STANLEY PLANE

STANLEY

1.



To put the Plane together lay the Plane Iron, bevel side down, on the Frog. Be sure the Roller on the Lateral Adjusting Lever, the end of the "Y" Adjusting Lever and the head of the Plane Iron Cap Screw are correctly seated.



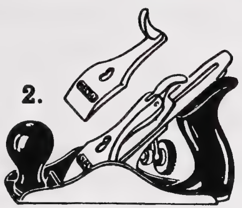
STANLEY NO. 4 OR 5

To adjust for the thickness of the shaving sight along the bottom of the Plane and turn the Adjusting Nut until the cutting edge projects about the thickness of a hair.

4.

To adjust for the evenness of the shaving sight along the bottom of the Plane and move the Lateral Adjusting Lever toward the right or the left.

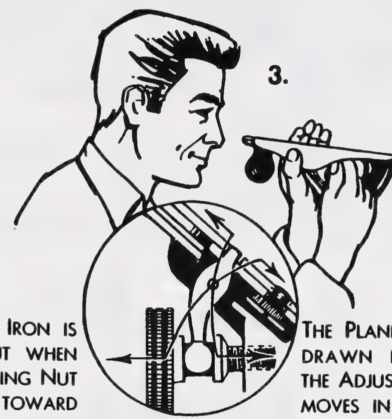
2.



Slip the Lever Cap under the Lever Cap Screw and press down the Cam. If the Plane Iron is in the correct position the Cam will easily snap in place. If the Cam will will not snap in place easily, slightly loosen the Lever Cap Screw.

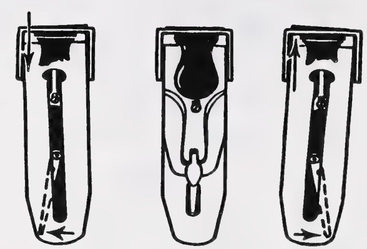
If the Plane Iron, is not firmly held when the Cam is in place slightly tighten the Lever Cap Screw.

3.



The Plane Iron is pushed out when the Adjusting Nut moves out toward the handle.

The Plane Iron is drawn in when the Adjusting Nut moves in toward the Frog.



Knob, Lever Cap and Plane Iron Cap removed to show the action of the Lateral Adjusting Lever.

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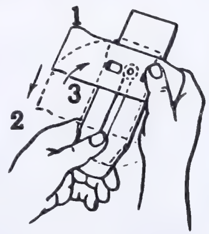
STANLEY

HOW TO ASSEMBLE THE

STANLEY DOUBLE PLANE IRON

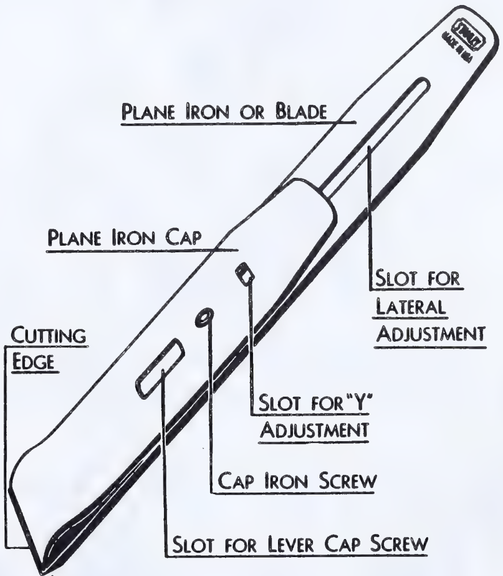
STANLEY

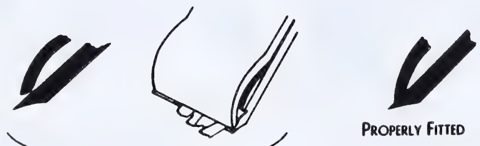


TO PUT THE PLANE IRON AND THE PLANE IRON CAP TOGETHER. 1—LAY THE PLANE IRON CAP ON THE FLAT SIDE OF THE PLANE IRON, AS SHOWN, WITH THE SCREW IN THE SLOT. 2—DRAW THE PLANE IRON CAP BACK. 3—TURN IT STRAIGHT WITH THE PLANE IRON.

4—ADVANCE THE PLANE IRON CAP UNTIL THE EDGE IS JUST BACK OF THE CUTTING EDGE OF THE PLANE IRON. THE PLANE IRON CAP MUST NOT BE DRAGGED ACROSS THE CUTTING EDGE.

THE PLANE IRON CAP SHOULD EXTEND 1 mm BACK OF THE CUTTING EDGE FOR GENERAL WORK. ON CROSS GRAINED OR CURLY WOOD IT SHOULD BE AS NEAR TO THE CUTTING EDGE AS POSSIBLE.

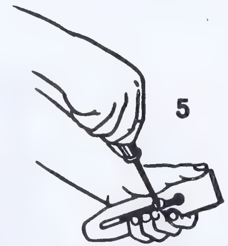




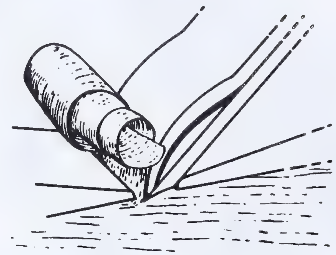
POORLY FITTED

PROPERLY FITTED

EDGE OF PLANE IRON CAP MUST FIT TIGHT TO PREVENT SHAVINGS WEDGING UNDER IT, PILING UP AND CHOKING THE PLANE.



5—HOLD THE PLANE IRON AND THE PLANE IRON CAP FIRMLY AND TIGHTEN THE SCREW TO HOLD THE TWO PARTS TOGETHER.



THE PLANE IRON CAP BREAKS AND CURLS THE SHAVING. TOGETHER WITH THE TOE OF THE PLANE IT PREVENTS THE WOOD SPLITTING AHEAD OF THE CUTTING EDGE, PRODUCING A SMOOTH SURFACE. THE PLANE IRON CAP ALSO SERVES TO STIFFEN THE PLANE IRON.

STANLEY TOOLS
NEW BRITAIN, CONN., U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 12
BY R. O. REGER

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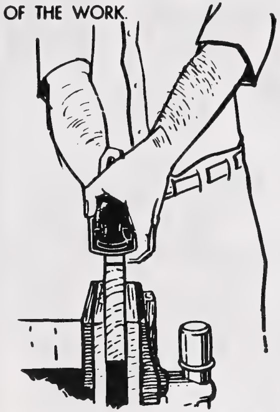
STANLEY

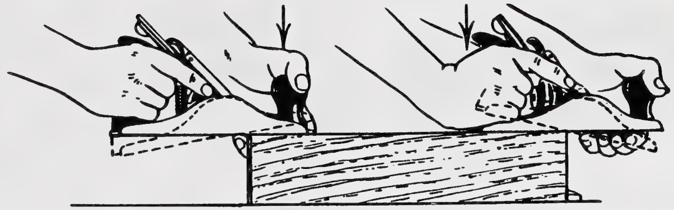
HOW TO USE THE
STANLEY PLANE

STANLEY

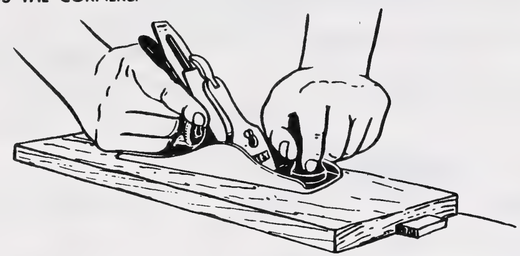
<ins>To start planing</ins> take an easy but firm position directly back of the work.



Hold the plane square with the work face of the work.



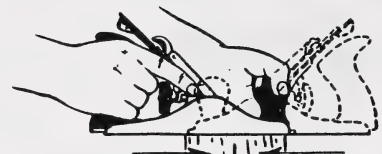
<ins>To cut a smooth straight edge</ins> the Plane is pushed with the grain, that is in the up hill direction of the fibres.
<ins>To keep the Plane straight</ins> press down on the knob at the beginning of the stroke and on the handle at the end of the stroke. Avoid dropping the Plane as shown by the broken lines. It rounds the corners.



<ins>To obtain a smooth surface</ins> plane with the grain. If the grain is torn or rough after the first stroke reverse the work.
If the grain is cross or curly, sharpen the Plane Iron carefully, set the Plane Iron Cap as near the Cutting Edge as possible and adjust the Plane Iron to take a very thin even shaving.

It is easier to plane a long edge straight with a long plane than with a short one. A long plane bridges the low parts and does not cut them until the high spots are removed.

<ins>At the end of the stroke</ins> the weight of the body should be carried easily on the left foot.



Plane End Grain half way from each edge.

If the Plane is pushed all the way the corners will break.

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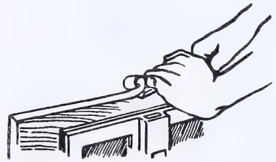
STANLEY

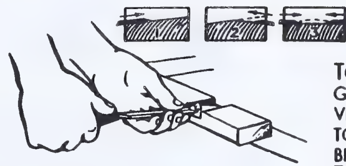
HOW TO USE

THE STANLEY CHISEL

HORIZONTAL CHISELING

STANLEY





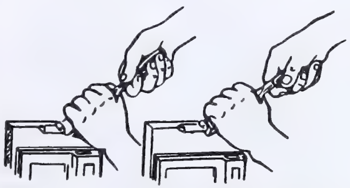
KEEP YOUR CHISEL SHARP

SEE STANLEY CHARTS NO C10 AND NO C11 FOR GRINDING AND WHETTING PLANE IRONS. THE SAME APPLIES TO CHISELS

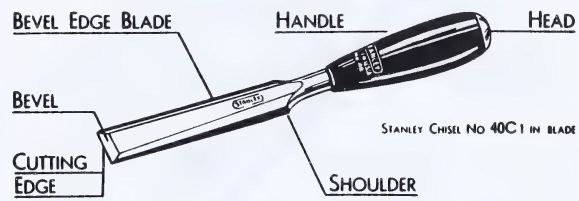
TO CUT, HORIZONTALLY, WITH THE GRAIN: THE CHISEL IS HELD SLIGHTLY TURNED TO ONE SIDE AND THEN PUSHED FROM THE WORKER. IT IS HELD WITH THE BEVEL DOWN FOR A ROUGHING CUT AND WITH THE BEVEL UP FOR A PARING CUT.

TO CUT, HORIZONTALLY, ACROSS THE GRAIN WITH THE WORK HELD IN THE VISE: PRESS THE FOREFINGER AND THUMB TOGETHER ON THE CHISEL TO ACT AS A BRAKE.

TO AVOID SPLINTERING THE CORNERS, CUT HALF WAY FROM EACH EDGE TOWARD THE CENTER. REMOVE THE CENTER STOCK LAST.



TO CUT A CHAMFER: HOLD THE CHISEL INCLINED TO ONE SIDE PARALLEL TO THE SLOPE OF THE CHAMFER AND CUT AS IN CHISELING HORIZONTALLY WITH THE GRAIN.



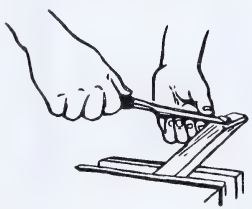
STANLEY CHISEL NO 40C1 IN BLADE

TO CUT ACROSS THE GRAIN WITH THE WORK HELD AGAINST THE BENCH HOOK, THE HEEL OF THE LEFT HAND STEADIES THE WORK WHILE THE FINGERS PRESS THE CHISEL FIRMLY AGAINST THE WOOD.

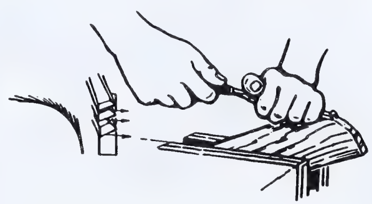
THE CHISEL IS CONTROLLED WITH THE LEFT HAND, PRESSING FIRMLY ON THE CHISEL AND THE WOOD. THE POWER IS APPLIED WITH THE RIGHT HAND. THE CHISEL IS HELD SLIGHTLY TURNED SO THE EDGE SLIDES ACROSS THE WORK OR THE CHISEL IS MOVED TO THE RIGHT AND LEFT AS IT IS ADVANCED, TO GIVE A SLIDING ACTION TO THE CUTTING EDGE. THIS IS EASIER THAN A STRAIGHT THRUST AND LEAVES A SMOOTHER SURFACE ON THE WORK.

AT ALL TIMES KEEP BOTH HANDS BACK OF THE CUTTING EDGE.

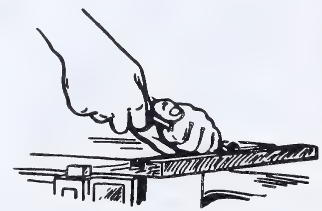
TO CUT A STRAIGHT, SLANTING, CORNER IS THE SAME AS HORIZONTAL CHISELING. THE WORK IS HELD IN THE VISE WITH THE GUIDE LINE HORIZONTAL.



TO CUT A CHAMFER ON END GRAIN, THE CHISEL IS MOVED SIDEWAYS ACROSS THE CORNER OF THE WORK, HELD SO THAT THE CHISEL MAKES A SLIDING HORIZONTAL CUT.



TO CUT A ROUND CORNER, THE CHISEL IS MOVED SIDEWAYS ACROSS THE THE WORK MAKING A SERIES OF CUTS CLOSE TOGETHER EACH ONE TANGENT TO THE CURVE.



IF THE WORK IS WIDE THE CHISEL IS HELD BEVEL DOWN, SO THE HANDLE WILL CLEAR THE WORK AND THE BLADE WILL NOT DIG IN TOO DEEP, AS IT IS PUSHED FORWARD.

STANLEY TOOLS
NEW BRITAIN, CONN., U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 17
BY R. O. REGER

PRINTED IN U.S.A.

STANLEY

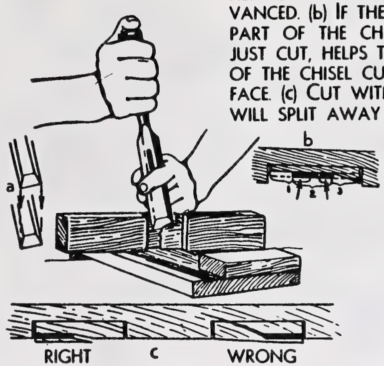
HOW TO USE

THE STANLEY CHISEL

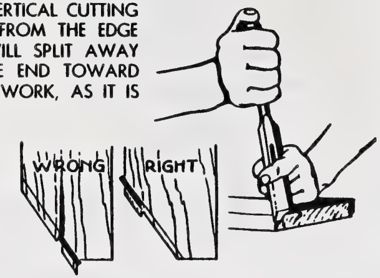
VERTICAL CHISELING

STANLEY

To cut, vertically, across the grain (a) the chisel should be slightly tilted to one side to give a sliding action to the cutting edge, or it may be held straight and moved to one side as it is advanced. (b) If the surface is wider than the chisel, part of the chisel pressed against the portion just cut, helps to guide and keep in line the part of the chisel cutting a new portion of the surface. (c) Cut with the grain, so the waste wood will split away from the guide line.

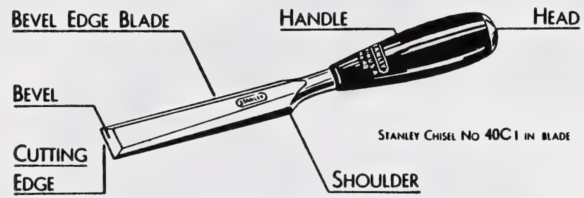


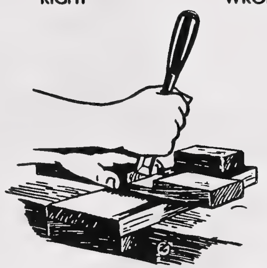
To cut, vertically, a slanting corner use the chisel in the same manner as in vertical cutting across the grain. Always work from the edge toward the end, so the wood will split away from the line. Working from the end toward the edge will split and ruin the work, as it is cutting against the grain.



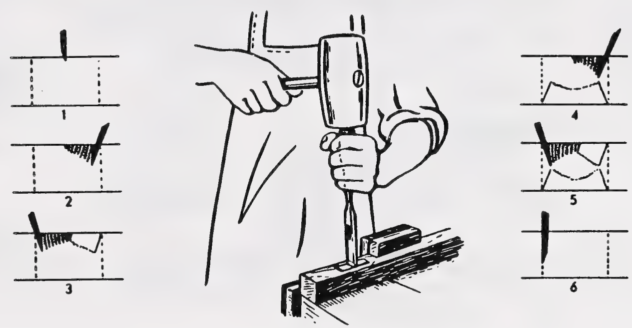
KEEP YOUR CHISEL SHARP

See Stanley Charts No C10 and No C11 for grinding and whetting Plane Irons The same applies to Chisels





To clean the corners of a tenon, notch, dado or rabbet: grasp the chisel by the blade, near the edge; raise one corner of the cutting edge by tilting the handle away and draw the chisel toward you. The work is held by the left hand while the chisel edge and one corner, guided by the right hand, act like a knife.



The mallet may be safely used on the chisel when the cutting edge is across the grain. When the edge is with the grain, the use of the mallet is very likely to split the wood. The mallet may be used on the chisel to beat out a mortise, to cut the ends of a mortise (when the bulk of the material has been bored out), when the wood is hard and in roughing out (when there is a large amount of material to be removed).

To cut a concave curved corner: hold the bevel side of the chisel against the work with the left hand; with the right hand press down and draw back at the same time, giving a sweeping curved direction to the cut.
Always work with the grain from the edge toward the end.

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New Britain, Conn., U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 18
BY R O REGER

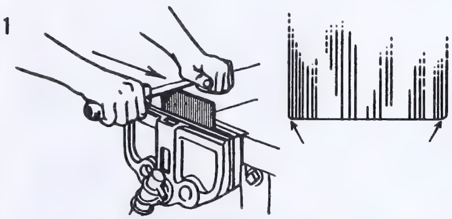
Printed in U.S.A.

STANLEY

HOW TO SHARPEN AND USE
THE STANLEY HAND SCRAPER

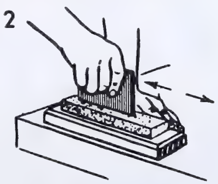
STANLEY

1



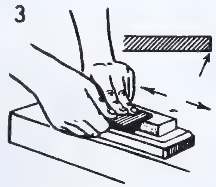
<u>To Sharpen the Hand Scraper:</u> File the edges square and straight by drawfiling with a smooth mill file. Round the corners slightly, as shown above.

2



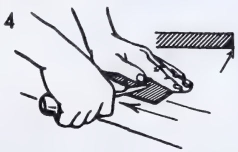
Whet the edge, holding the blade square to the surface of the oil stone. Some prefer to hold the scraper square to the edge of the oil stone.

3



Remove the burr by whetting the scraper flat on the oil stone. The edges should be very smooth and sharp.

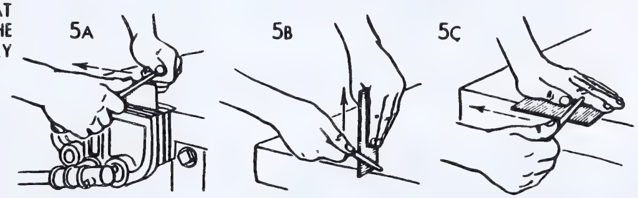
4



Draw the edge with three or four firm strokes of the burnisher held flat on the scraper.

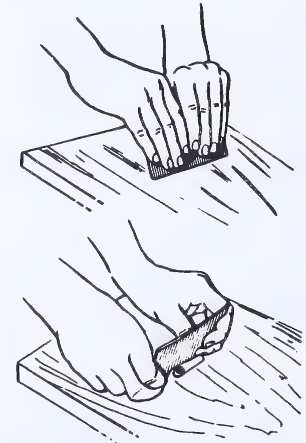
Stanley Hand Scraper No OHS - 3 in x 5 in

The Hand Scraper is used for the final smoothing before sandpapering. It removes the slight ridges left by the plane. It is also used to smooth surfaces that are difficult to plane because of curly or irregular grain.

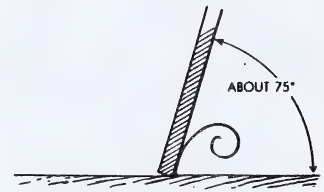


Turn the edge with a few strokes of the burnisher. The scraper can be held in any of the three ways shown above. Draw the burnisher toward you the full length of the blade, with a sliding stroke.

To turn the edges out, the burnisher is held at 90° to the face of the blade for the first stroke. For each of the following strokes, tilt the burnisher slightly until at the last stroke it is held at about 85° to the face of the blade. A drop of oil on the burnisher helps.



The hand scraper can be either pushed or pulled as the grain of the wood demands or whichever is more convenient.



The hand scraper is held firmly between the thumb and fingers at an angle of about 75° and sprung to a slight curve, by pressure of the thumbs.
Dust, instead of a shaving, indicates a dull scraper.

STANLEY TOOLS
New Britain, Conn., U.S.A.

Educational Department
Chart No. 28
By R. O. Reger

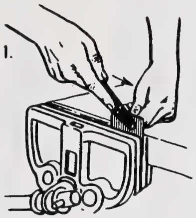
Printed in U.S.A.

STANLEY

HOW TO SHARPEN AND USE
THE STANLEY CABINET SCRAPER

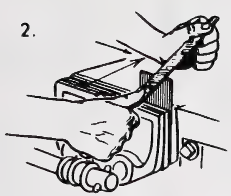
STANLEY

1.



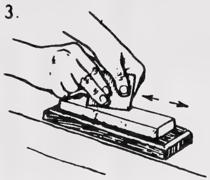
To Sharpen a Bevel Edge Scraper Blade Remove the old burr with a smooth mill file held flat against the face or flat side of the blade

2.



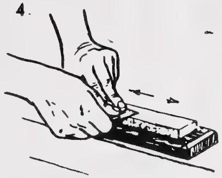
File or grind a bevel of about 45° Push the file forward and to the side with one sliding motion

3.



Whet the bevel side of the blade on the oil stone

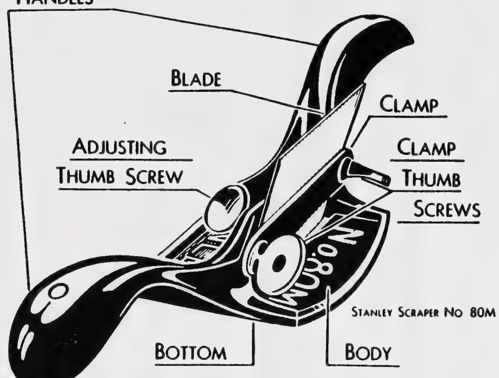
4.



Whet the face side of the blade to remove the wire edge

5.

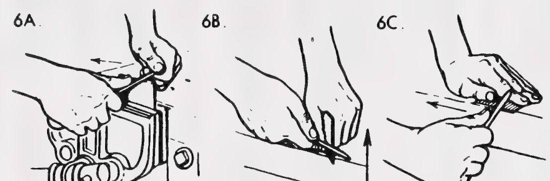
Draw the edge with a few firm strokes on the face side of the blade Hold the burnisher flat on the face side of the blade



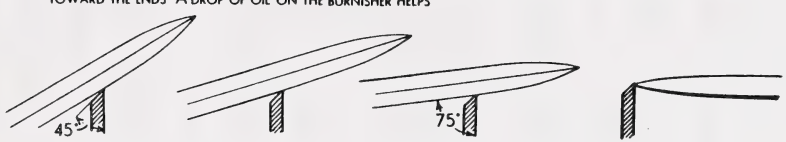
Stanley Scraper No 80M

The Cabinet Scraper is used for the final smoothing before sandpapering It removes the slight ridges left by the plane It is also used to smooth surfaces that are difficult to plane because of curly or irregular grain

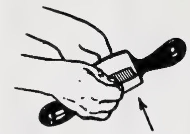
6A. 6B. 6C.



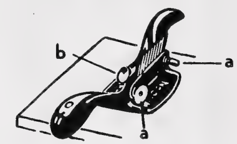
Turn the edge with a few firm strokes of the burnisher on the bevel side of the blade The scraper can be held in any of the three ways shown above Draw the burnisher toward you the full length of the blade, with a sliding stroke Some prefer to stroke both ways from the center toward the ends A drop of oil on the burnisher helps



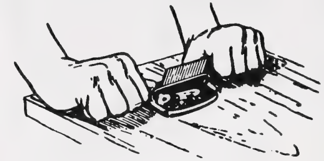
The first stroke should be made with the burnisher held at an angle, a little greater than the bevel Increase the angle until, at the last stroke, the burnisher is held at about 75° to the flat face of the blade If the edge should be turned too far over, it can be raised by drawing the the point of the burnisher along the edge, under the burr



To Adjust and Use the Cabinet Scraper Loosen the adjusting thumb screw and the clamp thumb screws Insert the blade from the bottom with the bevel side towards the adjusting thumb screw



Bring the edge of the blade even with the bottom of the scraper body, by standing it on a flat surface and pressing the blade lightly against the wood Tighten the clamp thumb screws a a Bow the blade by tightening the adjusting thumb screw b, to make it project enough to take a thin shaving If one corner of the blade projects too far, it can be drawn in by tapping the side of the blade near the top



Try the scraper and change the adjustment until it takes a thin even shaving Hold it turned a little to the side to start a cut The Cabinet Scraper is usually pushed but it can be pulled Dust, instead of a shaving, indicates a dull scraper

STANLEY TOOLS
New Britain, Conn. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 29

Complete the following exercises and send them in for correction.

EXERCISE 1

1. The Jack Plane is about ________ long with a ________ wide cutter. It is an 'average' size in the plane family of tools.

2. Which bench plane is the one most commonly used by carpenters?

   ____

3. When a bench plane is to be sharpened we have to remove several parts. List the first two of these in the order they are removed.

   (a) ____

   (b) ____

4. How far should the plane iron project past the plane iron cap for general planing?

   ____

5. To ensure a smooth, straight job with the least effort, the plane iron should be

   ________________ and ________________ ________________.

6. Explain the proper way to apply pressure to a hand plane as you begin the stroke, in the middle of the stroke, and as you end the stroke.

   ____

   ____

   ____

   ____

7. The lever cap should not have to be jammed onto a plane. You should be able to

   hold the plane in one hand and ______________________________.

8. What could happen if a plane iron is handled carelessly while it is being installed into a hand plane?

   ____

   ____

   ____

9. What is the purpose of the lateral adjusting lever on a hand plane?

   ____

   ____

   ____

10. A hand plane should not push overly hard. What are three things that can be done to make it easier to push?

    (a) ______________________________

    ____

    (b) ______________________________

    ____

    (c) ______________________________

    ____

11. To check for warp and twist (wind) in a board you place a straight-edge (such as the framing square or a level) __________ the board, __________ on the board, and __________ __________ __________ diagonally.

12. (a) If you slide a plane completely across a board when planing end grain, what happens to the opposite edge?

    ____

    ____

    (b) What are three methods which can be used to prevent this?

    (i) ______________________________

    ____

    (ii) ______________________________

    ____

    (iii) ______________________________

    ____

13. The #60½ block plane is smaller than the #9½ and the plane irons sit in the plane at different angles; the #9½ is at approximately __________ degrees while the #60½ is about __________ degrees.

14. The flatter angle of the 60½ block plane makes it push easier but it becomes ______________________________ more quickly.

15. The harder the wood and the smoother the job required, the __________ the mouth of the plane.

16. When using a hand plane or wood chisel you should always work with the grain.

(a) What does this mean?

____

____

____

(b) Why do you go with the grain?

____

____

____

(c) What happens if you work against the grain?

____

____

____

17. What often happens if you use a mallet when chiseling along a line which runs parallel to the grain?

____

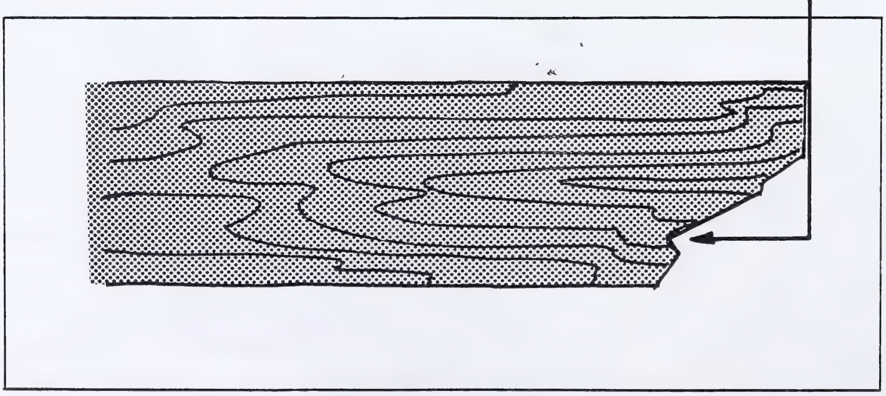
____

18. Why would you never use a mallet on a tang type wood chisel?

____

____

19. In the diagram below you would like to chisel the wood as shown. Explain how this would be done. Place your answer on a separate sheet of paper.



20. Which scraper would you use to scrape irregular shapes as this?

____

21. For what type of work would you use a jack plane?

____

____

22. For what type of work would you use a block plane?

____

____

23. For what type of work would you use a jointer plane?

____

____

24. For planing very soft wood the mouth of the plane could be adjusted to be larger. Of what advantage would this be?

____

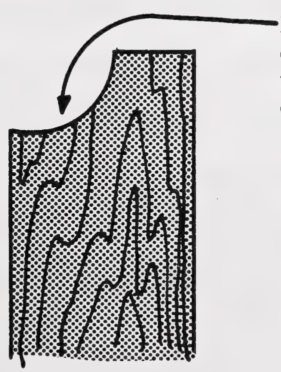
____

25. For what type of jobs is the hand scraper used? (name two)

____

____

____

26. 

Describe how you would chisel the curved portion of this piece of wood. (Use diagrams to aid in the explanation.)

27. How do you know when a hand scraper is dull?

____

28. What kind of tool is particularly good for forming the edges of plywood?

____

29. Describe with the aid of sketches how you would plane the end of the board.

30. What is wrong with a haphazard approach to a construction job?

____

____

____

____

31. Why would you start on the face of a board when planing it square?

____

____

____

____

32. Which two tools could be used to mark out the width of a board before starting to plane it to width?

(a) ______________________________

(b) ______________________________

33. Wood chisels can be hazardous. What is a very important safety rule to follow when using them?

END OF LESSON 2

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

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(If label is missing or incorrect)

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Lesson Number ____________

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Graded by: ________

Assignment Code: ______

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ALBERTA CORRESPONDENCE SCHOOL

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CUTTING TOOLS
Crosscut hand saw
Rip hand saw
General cutting with hand saw
Back saw
Coping saw
Keyhole and compass saw
Utility knife

INTRODUCTION

Although a large portion of cutting today is done with the aid of power saws, there are several reasons why you would choose a hand saw. Fine accurate work is still done with hand saws and one of the marks of a skilled trades person is their ability to use hand saws. Secondly, smaller pieces of material cannot be safely cut with power tools and hence a hand saw will have to be used. Also, it may take much longer to lay out a cord or set up a power saw than to do the cut with a hand saw, especially if only one or two cuts are to be made.

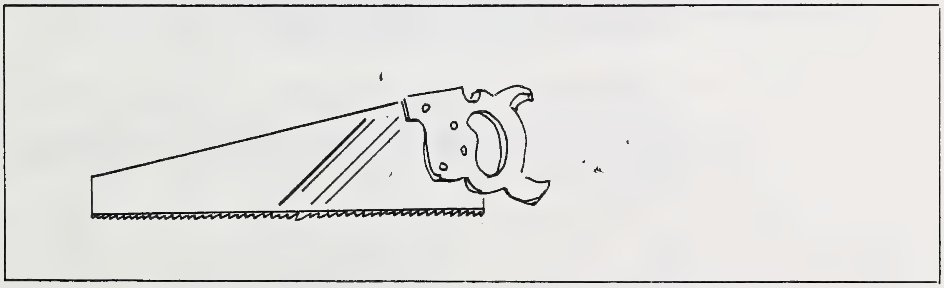
There are two general classifications of hand saws. Crosscut saws are used to cut across the grain of the wood with a slicing action. Most hand saws fall into this category (crosscut hand saw, back saw, coping saw, panel saw, keyhole saw etc). The other general classification is the rip saw (rip handsaw) which is designed to cut with the grain of the wood in more of a chiseling action.

CROSSCUT HAND SAWS

1. The Saw

The standard crosscut hand saw is 66 centimetres long. It can have a varying number of teeth points per centimetre. For cutting framing material crosscut saws are usually purchased with three points per centimetre whereas for cutting plywood panels they usually have four points per centimetre. The more points per centimetre the smoother the cut will be.

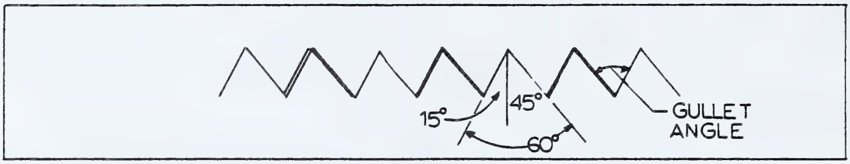
The crosscut hand saw is available in either a straight back (shown below) or a skew back (which is a curved back). The straight back is the most common.



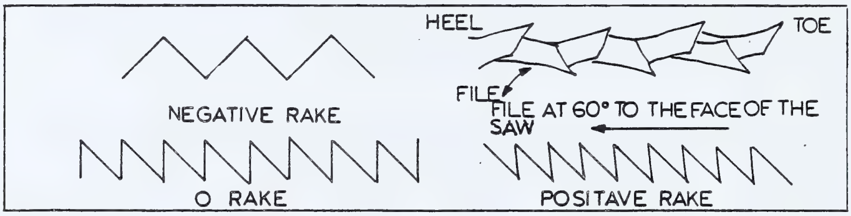
A slightly smaller crosscut hand saw is sometimes given the name PANEL SAW. It is 50 to 55 centimetres long and has four or five points per centimetre. It is lighter and easier to use than the standard crosscut hand saw and is handier for fine work with panelling.

2. The Crosscut Saw Teeth

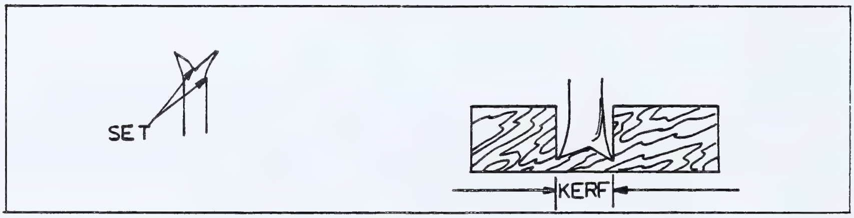
(a) NOTE: The angles on all cross-cut saw teeth are similar.All hand saws used by carpenters have 60° tooth angles and 60° gullet angles. Triangular files for sharpening saws have three 60° angles



(b) The difference in saws is in the rake angle. All of them have negative rake. A saw with a 15° negative rake cuts more smoothly but more slowly than a saw with a 5° negative rake. Crosscut saws cut fairly smoothly because they have about 15° negative rake.

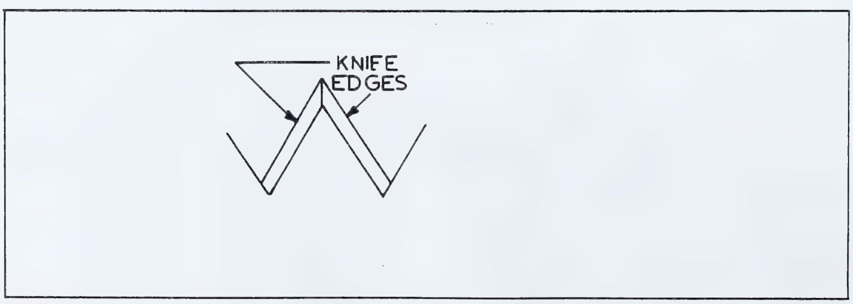


(c) Set (bending every second tooth outward the opposite direction -- see diagrams) is what makes the saw kerf wider than the saw blade itself. If the kerf is not wider than the saw itself it will pinch and bind, especially in green wood.



The more the set, saw teeth have the rougher the cut will be but less likely the saw will be to bind in the wood. Therefore, a three point handsaw used for cutting framing material (greener) will have more set (rougher and faster cutting) than a backsaw (six point) used for cutting casing (very dry). The backsaw will cut more slowly but will produce a smoother cut.

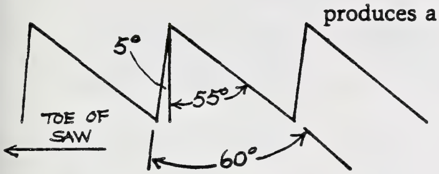
(d) Because cross-cut saws are cutting across the wood fibers they should have a slicing action like a knife in order to slice the fibres off at each edge of the cut. This is why a saw-filer holds the file at about a 60° angle to the face of the blade when filing a crosscut whereas rip saws are filed almost straight across (almost 90°).



RIP HAND SAW

This saw is identical in size (it is also 66 cm long) and appearance to the crosscut hand saw. However the rip hand saw has only two points per centimetre and is, therefore, a much rougher and faster cutting saw. The rip saw is also held at a steep angle (60°) to the work. Very little hand ripping is done today but it is a necessity at times and is certainly handier for short pieces (why set up a skilsaw and a power cord for ripping a 50 cm long piece of lumber?).

1. As for all hand saws, rip saws have 60° tooth angles and 60° gullet angles. However, the rake (5°) is much less negative than the crosscut (15°). This produces a faster but rougher cut (more of a chisel action).



2. Set of a rip saw is also quite coarse because a saw tends to bind more easily when cutting with the grain than across the grain (green lumber tends to squeeze the blade often).

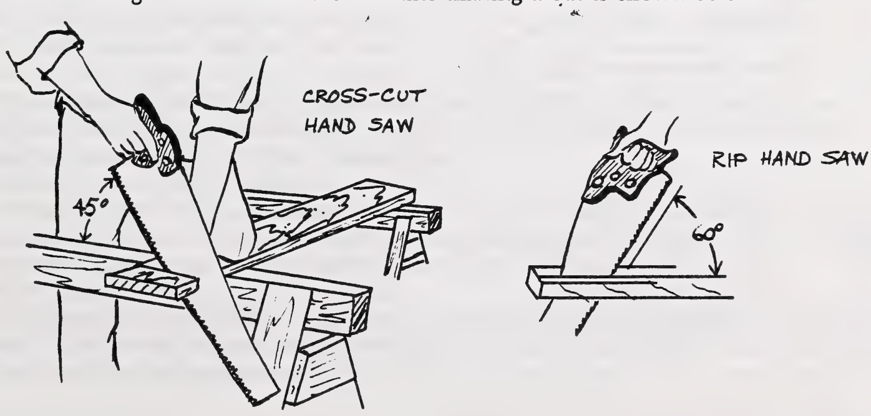
3. Rip hand saw teeth do not have to slice the edges of the cut as a crosscut hand saw does. Therefore when ripping flat chisel-like teeth are best. In fact, a rip saw can be compared to a row of wood chisels being pushed forward with the bevel edge trailing.

GENERAL CUTTING WITH HAND SAWS

Both crosscut and rip saws are used to cut lumber set on sawhorses. They are not bench tools. Lumber is set across a pair of sawhorses about 60 cm high so that the carpenter can hold a board steady with one knee while cutting. Long boards and panelling are easily accommodated on saw horses. Extremely small material can be held either by clamp or by nailing to a sawhorse.

1. Correct Angles

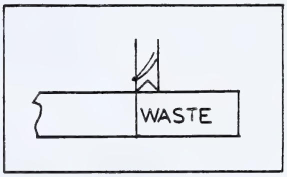
The correct angle to hold a hand saw while making a cut is shown below.



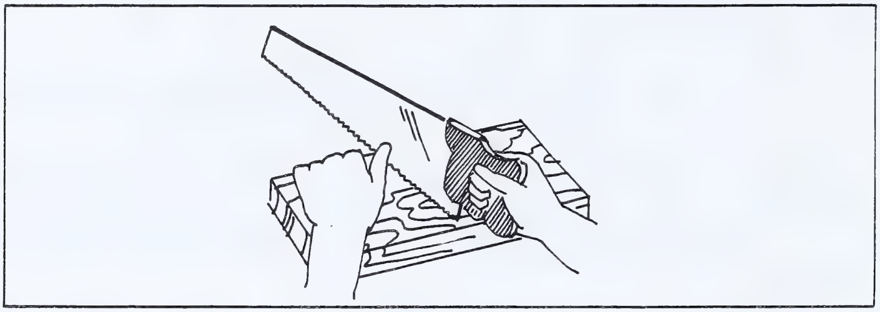
2. Procedure for Making a Cut

(a) Lay out the material to be cut. The layout lines should be on the good face of the material. Saw teeth tend to chip when they leave the work. Chips will occur along the underside of the material. They will not affect appearance if the poorer side is placed downward.

(b) Cut on the waste side of the line but close to the line.



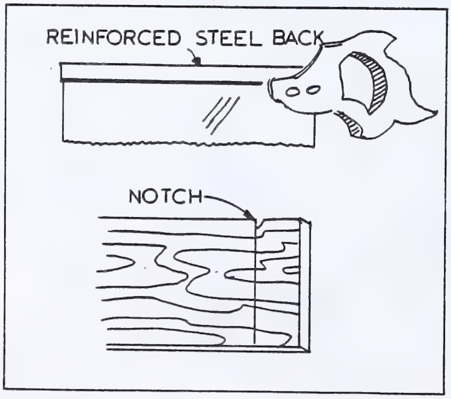
(c) Begin the cut with the heel and draw the saw towards you two or three times to start a kerf. Your left thumb (if you are right handed) can be placed against the side of the saw. By keeping the saw against your thumb it will not wander off the line.



(d) You should be standing so that the layout line, the saw, your arm, and your shoulder are all in a straight line. In this way the saw will move straight back and forth allowing you to cut a straight line.

(e) Use long easy strokes once the cut is started. It is best to move your thumb away once the cut is started. Use the entire length of the blade. One long stroke is equal to two short strokes. Do not force the saw. It is designed to cut at a certain rate of speed (when clean and sharp) and will buckle if pushed too hard. A sharp saw will feed itself into the wood as you slide it back and forth. At times, however, a slight pressure may be necessary.

BACKSAWS

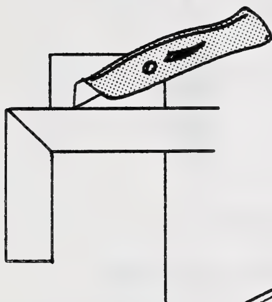


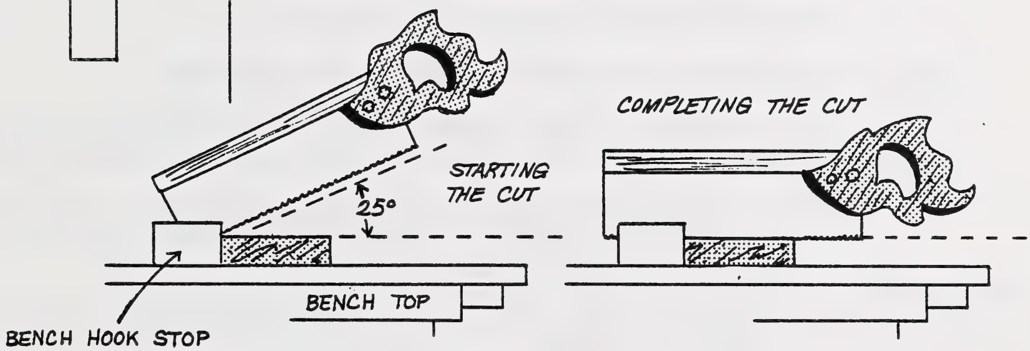
Backsaws have blades with reinforced steel backs to keep them rigid and straight. Backsaws which are 30 cm, 35 cm, or 40 cm long could be used for freehand cutting, or with a bench hook or small wooden mitre box. Backsaws which are 60 cm, 66 cm, 71 cm, and 76 cm in length would be used with an adjustable, steel mitre box as they are unwiedly without guides. These larger saws are sometimes called mitre saws. Although the standard points per centimetre for mitre box saws is about four, the smaller back saws are available with teeth as fine as six points. A handy, useful size for a carpenter would be a 35 cm long back saw with four points per centimetre. These saws make very fine, smooth cuts and are used for finish work only (cutting casing, baseboard, and other mouldings). Mark out the work with a sharp pencil. In order to get the saw started easier make a small notch with a knife, on the waste side of the line.

For a very accurate work cut all the way across with a knife before sawing.

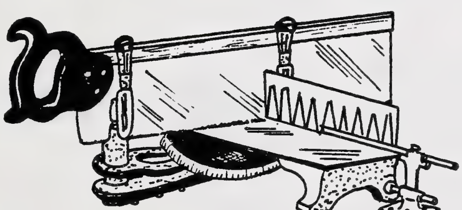
Regardless of whether you do the layout with a pencil or a knife the layout lines should go across the face and down the edges. This will give greater accuracy.

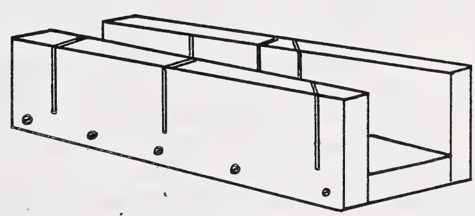
To start a cut with a back saw, position the saw along the waste side. Raise the saw to a 25° angle as shown. The side of the back saw should be rubbing against the bench hook so the saw will not wander. Draw the saw back two or three times until the saw will start correctly. Then move the saw back and forth. As the cut progresses gradually lower the saw until it is being operated horizontally. Continue until the board is cut off.





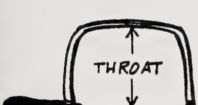
Below is a diagram of the two most common mitre boxes. These are used along with a back saw or mitre saw for accurately cutting standard angles of 45° and 90°.





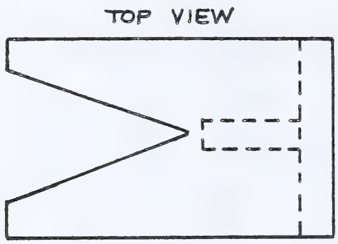
COPING SAWS

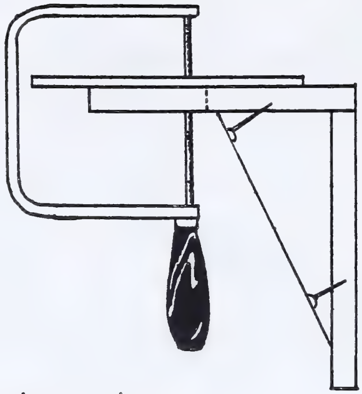
A coping saw is designed to make irregular shaped cuts in thin material. They can be purchased with throats of various lengths. The ones with throats as long as 50 centimetres are generally known as fret saws.



The teeth of a coping saw should ALWAYS point towards the handle. In this way you are always cutting with the handle below the work and you can follow your layout lines more easily. Also the saw will be pulling the work towards the bench.

A coping saw jig (or v-block) gives better support to fine, intricate work although work is often done on a saw horse or bench. If a workbench is used, make sure you will not nick it with the saw.





Below are the steps to follow when using a coping saw

1. The guide lines should be on the best face of the material.

2. Start the saw by pulling downward on the saw so as to not chip the face. If the saw is to be started on a corner, the corner can be notched to prevent chipping.

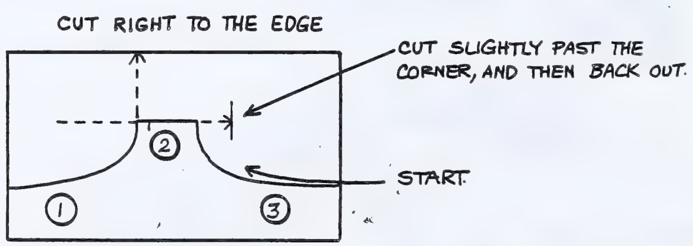
3. It is best to make sure that the saw blade stays straight up and down. Allowing it to angle forward or backward while turning a curve will throw the edge of the work off the vertical leaving a poor job.

4. Do not force the saw. If it binds, very carefully wiggle the saw handle sideways as you try to back out.

5. When completing the cut, let up on the feed pressure and reduce the length of stroke.

6. You must remember that a coping saw (or keyhole saw or compass saw) will cut a curve but not a corner. Where the work has curves and corners you will have to plan out your cuts.

   For example:



   (a) do cut 1 first -- cut right to the edge.

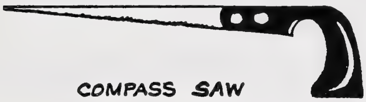
   (b) Then do cut 2 -- along the straight line.

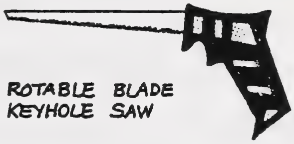
   (c) then cut curve 3.

COMPASS SAW AND KEYHOLE SAW

Compass and keyhole saws are both designed to make irregularly shaped cuts in relatively thick material such as framing in a house (a round or oval hole in a roof or floor for plumbing or heating ducts).

The only difference between the compass and the keyhole saws is in the width of the blade. The keyhole saw is the narrower of the two and can be used to cut sharper curves than the compass saw. They both bend quite easily so care must be taken not to jam the tip of the blade when cutting.





Below are the steps to follow when using a compass or keyhole saw.

1. Mark your lines on the good face as any chips will occur at the back where the saw leaves the material.

2. Use the same general procedure as for a crosscut or rip hand saw.

3. Use the wider section when following a gradual curve and the point when following a sharp curve.

4. If you have to cut out a section in the centre of the material, use a wood bit and bore a hole inside the guide lines to get the saw started.

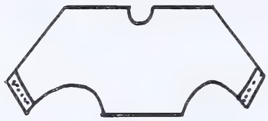
KNIVES

Although jackknives or common wooden - handled knives may still be used, the 'Utility' knife shown at the left is much more common today. Standard blades such as shown in the knife, can be easily reversed or replaced and there are a variety of special blades available, including short saw blades. Usually, there are four or five new blades stored in the handle. Utility knives are also available with retractable blades so the knife may be carried safely in your pocket. There are now 'breakaway' blades available so that all you have to do to get a new, sharp point is break off the end of the blade.

1. The hook blades have two razor-sharp hooked ends to cut linoleum and roofing materials.

2. The standard blades are used for cutting building paper, polythene tile, arborite, shingles, rugs as well as opening cartons and as a marking knife (described in lesson one).

3. The laminate scoring blade provides a unique method for cutting Formica Arborite, and other plastic laminates. Two or three firm strokes with either of the 2 points of the double edged blade scores the surface, ready for a clean, straight breaking of the laminate. For curves, score more deeply, then progressively break off the waste by hand or with a pair of pliers.



Complete the following exercises and send them in for correction.

EXERCISE 1

1. Power saws are in common use today, but they have not replaced hand saws. Give three reasons why hand saws are still in use.

   (a) ____

   ____

   (b) ____

   ____

   (c) ____

   ____

2. Explain how you can stop a crosscut hand saw from wandering sideways as you are starting a cut.

   ____

   ____

   ____

3. The negative rake angle of a cross-cut saw is ______° and of a rip saw is ______°.

4. The tooth and gullet angles (also the angles of a saw file) of hand saws are

   ____degrees.

5. What is the effect of putting more and more negative rake on the teeth of a crosscut saw?

   ____

   ____

   ____

6. Why are the teeth of hand saws set?____________________________

   ____

   ____

7. Explain what will happen to a saw cut if the saw teeth are set more than necessary.

____

____

8. Rip saw teeth cut like a series of chisels whereas cross-cut teeth cut more like a series of _______________________________________.

9. List three ways that a rip saw tooth is different than a crosscut saw tooth.

(a) ____

____

(b) ____

____

(c) ____

____

10. What is the correct angle to hold each of the following saws at when using them?

(a) crosscut hand saw_______________________________

(b) rip hand saw___________________________________

11. Why do you place the layout lines on the good face (the face that you will see on the finished project) of the material when laying out a cut for a hand saw?

____

____

____

12. What is the name given to a larger back saw?______________________

13. Explain why a cut is made on the waste side of a line and not down the middle of the line.

____

____

____

____

EXERCISE 2

1. In doing layout on a board to cut to length with a crosscut hand saw, the layout line is squared across the face only. However, when doing the layout for a cut with the back saw, lines are usually drawn down the edges as well as across the material. Why are these additional lines placed on the edge of the material for use with the back saw?

2. What type of saw would be used to cut the ends of material for making a picture frame?

3. How would you cut Formica, Arborite and other plastic laminates? What tools would you use?

4. What type of saw would you use for cutting accurate angles on baseboards?

5. What kind of saw would you use to cut a round hole in a floor to allow a pipe to be fitted through?

6. For very fine work, how do you start to make a cut with a backsaw?

7. What is a mitre box and what is it used for?

8. Give three reasons when it is more convenient to use a handsaw than a power saw?

(a) ______________________________

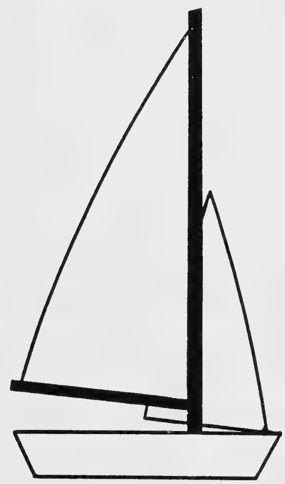
(b) ______________________________

(c) ______________________________

9. A (compass, keyhole) saw has a wider blade. Underline the correct answer.

EXERCISE 3

1. You want to cut this sail boat wall plaque entirely from a sheet of 6 mm thick plywood. It will be 200 millimetres in length.



(a) Which saw would work best to cut the smaller rectangular piece of plywood from the full sheet?

____

(b) Explain the procedure you would use to draw the sailboat design onto the plywood. (Include the proper names of the tools you need.) Include an explanation of how you get the correct size for the boat.

____

____

____

____

____

____

(c) Which saw would work best to cut out the sailboat?

____

(d) Explain the procedure you would use to cut out the sailboat? (Include the names of extra tools or materials that you would need.) List the order in which the cuts are made.

____

____

____

____

____

____

____

____

____

(e) How would the plywood be supported while doing the cuts?

____

____

____

____

END OF LESSON 3

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TOOL MAINTENANCE I

Care and storage of hand tools
Cleaning and polishing tools
Other cleaning methods
Smoothing rough edges
Rustproofing and oiling
Replacing wood handles
Refinishing wood handles

INTRODUCTION

Be sure to maintain both hand and power tools in excellent condition. This applies not only to sharpening, which will be covered in the lesson entitled "Tool Maintenance II", but to the general care of hand and power tools as well.

Remember, tools must be kept clean and polished plus free of defects if they are to work well. This means that they must be free of rust, tar, glue, wood sap, etc. You will find that a plane or chisel will slide over the work more easily, a power saw will not overheat as quickly or you will not get blisters as readily if tools are kept cleaned and polished.

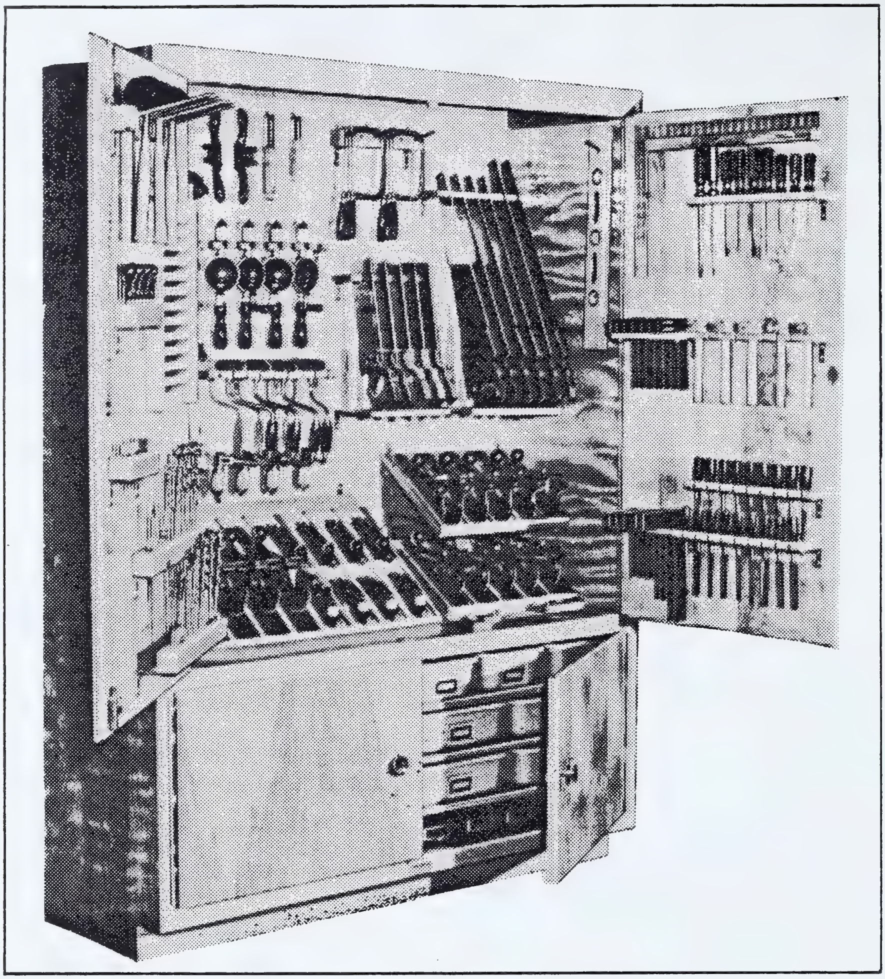
A quick appraisal of a carpenter's tool kit will give you a reasonable indication of his attitude and whether his work will be neat and carefully done or sloppy and inefficient.

CARE AND STORAGE OF HAND TOOLS

Do not expect tools to remain in good condition if they are not stored in a reasonable manner. Tools which are placed one on top of another on a work bench or piled into a tool box will damage each other. This damage is in two forms -- either dulled cutters or nicked or bent tools. These injuries are preventable with proper storage. Below are some recommendations for proper tool storage.

1. Have a secure storage space for each tool. Store tools in such a way that one tool will not touch the cutting edge of another. Put your tools away as soon as you are finished using them.

2. When you set up your storage space, whether it be in a tool box or on a wall, store the heavy tools at the bottom and the lighter tools on top. If a heavy tool is dropped and lands on a smaller tool a lot of damage could result.



3. The storage area should be dry as any moisture will cause rusting. Most woodworking tools will rust easily and quickly if allowed to get wet. In fact, they will rust on damp summer days even if stored inside. They should be protected by coating them with a light layer of wax or oil. (This will be discussed later in the lesson.)

Remember it is easier to keep tools in good shape than to recondition them. Reconditioned tools never look as good as new ones.

CLEANING AND POLISHING TOOLS

There is a certain type of individual that no tradesperson, who appreciates working with good quality, sharp tools, can tolerate for long. That is the person who leaves tools dull and covered with grease, glue, paint, tar etc.It takes only a few seconds to wipe or wash tools clean when the glue, paint, etc. is fresh but considerable effort when they have hardened (dried). NEVER return borrowed tools in a messy condition -- you may want to borrow them again.

1. Cleaning Hand Tools

Water, turpentine, paint and varnish remover and varsol are all thinners (or solvents). They are excellent for cleaning rust, paint varnish and pitch off tools.

Some materials such as contact cement and lacquer have their own thinners and cleaners.

A general guide to cleansers for different cleaning jobs is given below.

(a) When rust is the problem, tools should be cleaned as soon as possible (rust etches into a steel surface). Wet the tool with water and, using a small piece of Wetordry sandpaper, sand with a circular motion until the steel is shiny and smooth (a piece of #320 Wetordry will be sufficient for light rust). If the rust is thick use small pieces of coarse (#180 Wetordry) sandpaper to remove the rust and then finish with a piece of finer (#280 or #320) sandpaper. If the rust is very thick use a putty knife (or old chisel) and a wire brush first to remove the heavy, loose rust and then finish as above.

(b) Wood sap may be scraped off and then washed off with turpentine. Finish as for rust.(see (a) section above)

(c) Burned on plywood glue or pitch may be removed by using a spray on type oven cleaner that is suitable for use on cold ovens. Follow the directions on the can. If all the glue or pitch is not removed polish as for rust.(see (a) section above)

(d) Tar can be scraped off or washed off with varsol, and the tools finished as for rust.

(e) Paint or varnish, when wet, may easily be removed with the proper solvent (water or varsol). However, when they have dried they have to be scrapped off or dissolved with paint and varnish remover. Read the directions on the can before using paint and varnish remover.

(f) Polyvinyl acetate (white) glue can usually be scraped off with a stiff putty knife but water will soften the dry glue after a short period of time (be careful not to soak too long -- steel will rust and wood will expand and crack).

(g) Grease, oil, or tree gum (which is not baked on) can be removed with varsol.

NOTE: Most of these solvents are poisonous, flammable, or corrosive and some are all three. Look for these three words of danger or the following signs:

POISON

FLAMMABLE

CORROSIVE

Many are not only poisonous if swallowed but are also poisonous to breathe and some can even be absorbed through your skin.

BE CAREFUL with all solvents except water. Some are less volatile than others but none are "safe".

EXAMPLE: Someone pours a can of gasoline on a pile of trash or wood. It is 35°C outside, and the gasoline is allowed to soak for ten minutes. On a calm day the gasoline fumes will ignite explosively for 10 m in each direction.

Use solvents in an open or well-ventilated area away from open flames such as furnaces, hot water heaters, gas radiants, etc, and refrain from smoking. When cleaning, always replace lids tightly on the containers, store away from heat, and remove every rag or piece of paper used for wiping off these solvents. Do not think because you are a good distance from a flame that you can safely use these solvents. They are volatile, which means that they vaporize and float through the air -- the warmer the air the faster they vaporize. Many explosions and fires have been caused by people believing they could clean clothes with varsol at the opposite end of a basement from a hot water heater.

2. Other Cleaning Methods

(a) Irregular surfaces such as hand planes with corrugated bottoms, the twists of drills, gullets of saw teeth, etc, may be cleaned and polished by hand with a wire brush.

A wire brush or a buffer used on a grinder or a heavy duty portable drill is excellent for cleaning and polishing larger tools. However, as with all power tools, be VERY CAREFUL! A tool, such as a wood chisel, which is allowed to catch in a spinning wire brush will be hurled through the air and could cause serious injury or death either to yourself or someone else in the vicinity.

You SHOULD NOT use any power tools, that you have not been taught to use, unless an experienced person is with you. Each power tool has it's own special safety problems of which you should be aware.

(b) The framing square is a special case. Wood sap, tar, paint, etc. may be cleaned out with the point of a scratch awl or nail. Do not use coarse sandpaper to polish the square unless absolutely necessary as this will remove the protective finish. When the square is cleaned and polished (and dry) put a few drops of white or yellow enamel on it and rub the enamel into the markings on the square until the main surface is clean and the markings are clearly visible. Leave overnight to dry and rub lightly with a bar of paraffin wax.

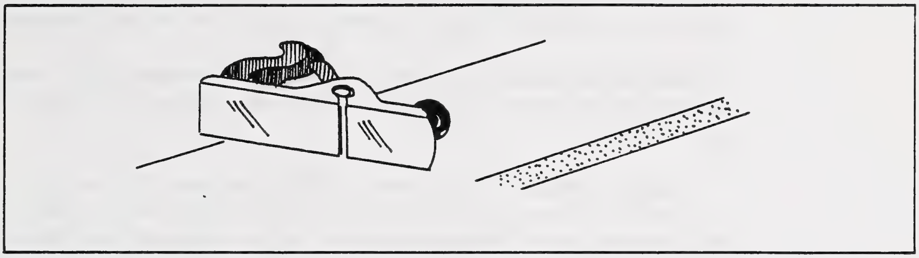
NOTE: A blued finish may be applied to a square if the protective finish has worn off. A gun bluing kit, with directions, may be purchased from most sporting goods stores.

(c) The final polish on steel tools should be done with very fine (#400) Wet or dry sandpaper or steel wool and kerosene (coal oil). Kerosene will not cause tools to rust and helps to produce a smooth, polished surface. It is also one of the least volatile solvents.

SMOOTHING ROUGH EDGES

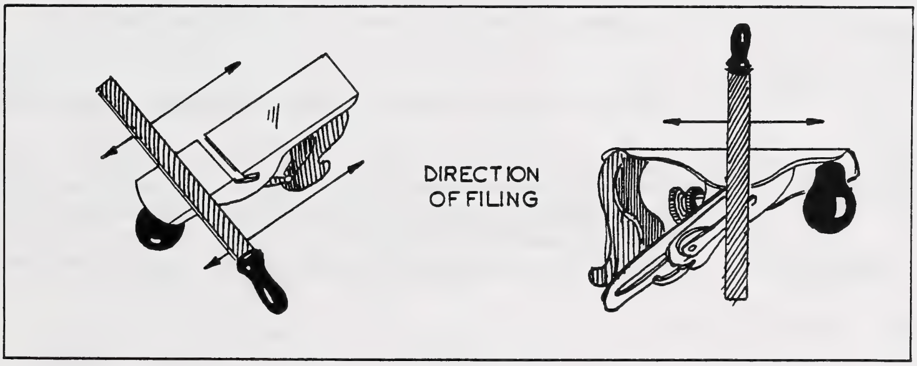
Many people throw their tools into a toolbox, a sack, or a drawer. They may also pile a number of tools onto a bench when they are working. These people will have to learn another type of maintenance -- for removal of chipped and gouged edges. These chips tend to scratch the wood you are planing.

Example of rough edge on a jack plane

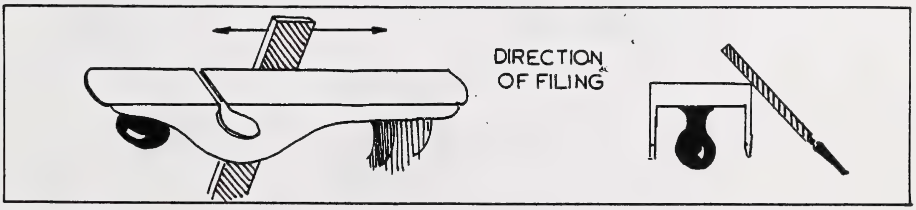


Obtain a 15 cm - 20 cm file. A flat mill bastard, single cut file is the best as it produces a very smooth cut.

Hold the file flat across the bottom of the plane (make sure the plane iron is retracted into the base) and file gently. When the base is smooth file on the side. File just enough to remove the burr.



The last step is to hold the file at a 45° angle to the bottom side and draw file the corner smooth. File gently just enough to smooth over the burr. Both sides, the toe and the heel as well as the mouth may be smoothed in this manner.



RUST PROOFING AND OILING

After a tool has been cleaned and polished it should be sharpened (if applicable) and then coated with a thin film of paraffin wax to help prevent rusting and material from sticking to the steel. A film of paraffin wax will also help a handsaw slide freely through lumber or decrease the friction of a plane bottom as it passes over the surface of a material. Bars of paraffin wax may be purchased in most grocery stores.

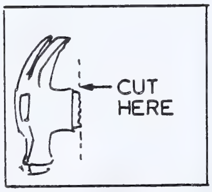
A thin coat of wax is applied most easily if both the wax and the steel are cool or cold. Warm wax tends to ball up on warm material. Paraffin wax is much better to use than oil because it does not attract dust and dirt as much and does not stain wood and clothing as does oil.

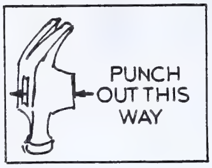
To form a thin film of wax on a steel surface, first rub a bar of wax on the area to be protected; then, using a small block of wood with sharp edges, rub off excess wax (as much as possible). This will leave a thin film of wax on the surface.

Most tools should be cleaned, polished, and protected in this manner; however, do not put wax on some surfaces such as the striking face of a hammer or on the top of a cold chisel, etc.

Another method of rust control is oiling the tools. This method is not recommended as oil will stain wood and it is near impossible to remove the stain. However for longer term storage, oil will leave a rust proof finish which will keep the tools better looking. This oil will, of course, have to be removed usually by careful wiping before the tool is used.

REPLACING WOOD HANDLES

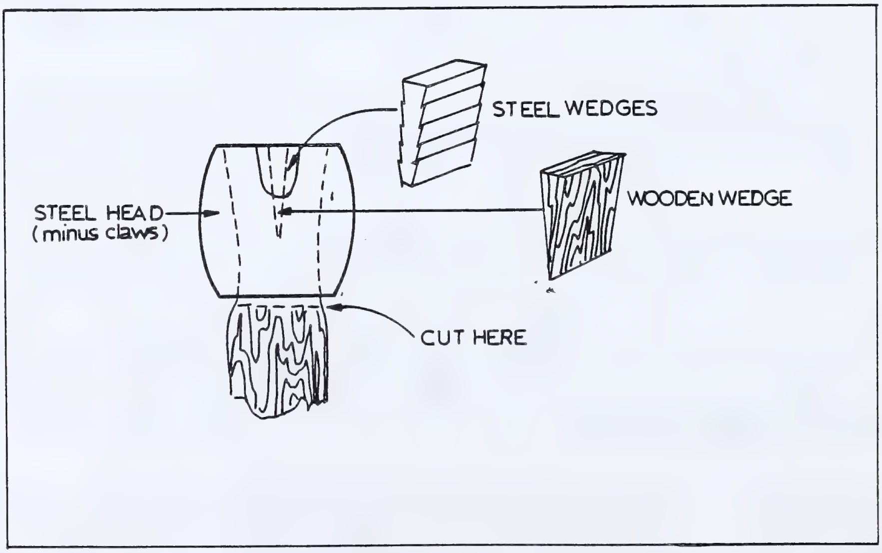




To replace a broken wood hammer or hatchet axe handle:

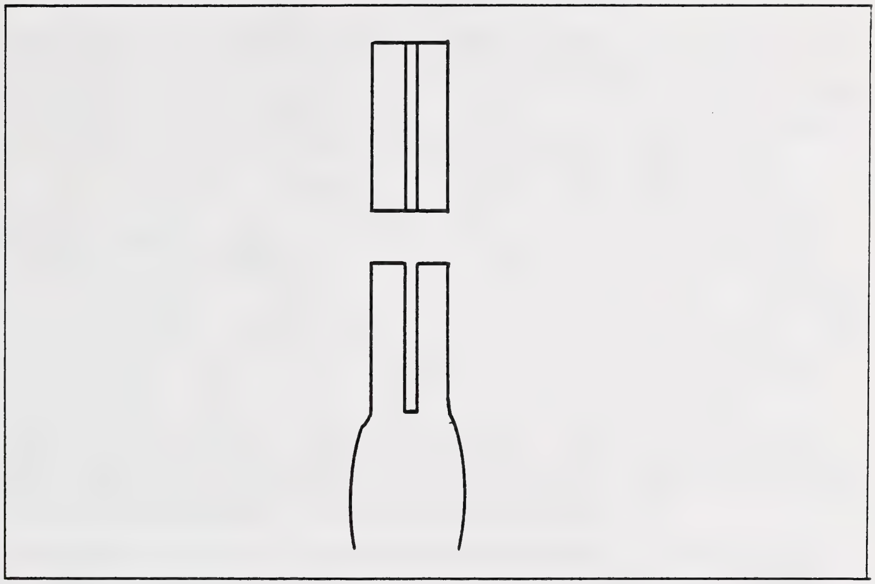
1. Cut the old hammer handle off about 3 mm - 6mm below the base of the head.

2. Punch the handle out forward (the hole for the handle is wider at the front than at the back). If it is difficult to remove, drill three or four holes with a small drill and then punch the handle out. Save the steel wedges, if any were used.



3. Buy a new handle. It should be complete with a wide wood wedge and two small steel wedges. You may have to buy these wedges separately. However, if you've saved the old steel wedges and you make a new wood wedge, that is satisfactory. The wood wedge should be hardwood.

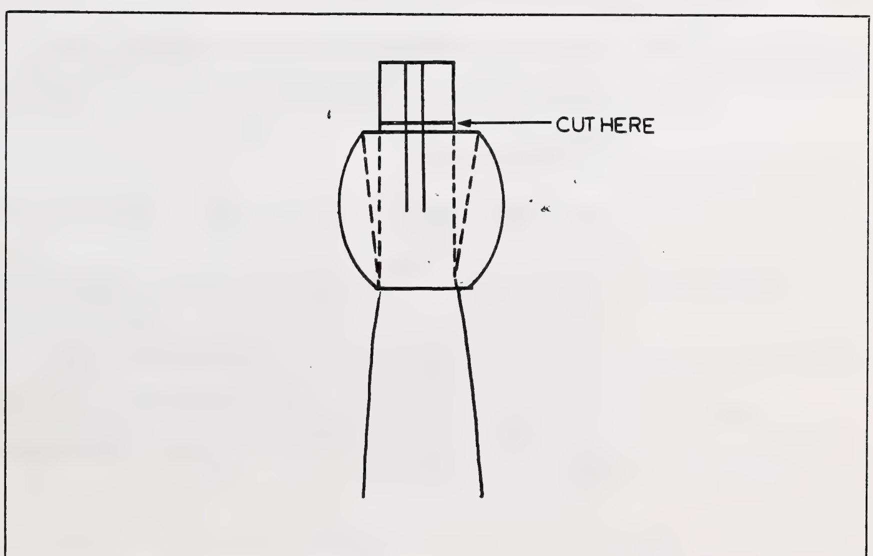
4. Shape the new handle (forming tool or file) to fit tightly through the hole in the back of the handle. If the new handle does not have a saw cut lengthwise to receive the wood wedge (most do have) then you will have to make a saw cut before you drive the handle into the head.



5. Tap the handle firmly into the head.

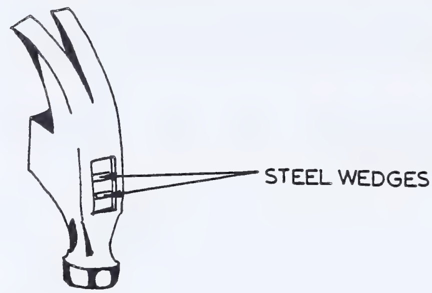
6. Hold the hammer handle with the head up. Tap the back end of the handle firmly on a solid object such as an anvil. This will make the handle seat firmly onto the head. Do not strike too hard or the back end of the handle will split.

7. If the handle projects through the head more than 3 mm then cut it off about 3 mm before wedging.



8. Drive the wood wedge firmly into the saw cut. If you hit too hard you will split the wood wedge before it is seated.

9. Drive the steel wedges. Space them so that you leave three equal areas of wood showing (approximately).



10. Make sure that the steel wedges are driven in even with the front of the head. Cut the handle off as close as possible to the front of the head -- a hacksaw works well. File off smooth with a coarse file or a wood rasp and coat the end of the handle with varnish or linseed oil.

To replace the neoprene rubber grip on a steel-handled hammer:

1. Roughen the steel handle slightly with sandpaper. Make sure it is clean and smooth.

2. Check the rubber grip. If it is in good condition clean it as much as possible inside. If it is badly split, buy a new grip.

3. Brush a coat of contact cement onto the steel handle.Make sure it is well covered. Set aside to dry.

4. Pour some contact cement into the empty handle and roll the handle around until it is completely covered on the inside.Drain excess contact cement. Do this step quite quickly as the contact cement sets very fast and you will have too much cement in the handle. Set the handle aside to dry. Try to hang it with the open end down to air-dry.

   Most contact cements only need 5 min - 10 min to dry under ideal conditions but can still be bonded an hour later.

5. Let the two set for about half an hour (read manufacturers instructions). Carefully set up to put the two together.Once the two surfaces contact fully they cannot be moved. If possible, tighten the hammer head in a vise (if it is a steel vise put a piece of rag on each side of the head to avoid marking the hammer head) with the handle straight up. Line up the neoprene grip over the steel handle with the open end just over the steel. Jam down quickly all the way.If it stops, it's stuck. Squeeze the handle firmly all the way down with your hands to fully seat the glue job.

REFINISHING WOOD HANDLES

Wood handles of tools may be cleaned in a similar manner to steel. Handles often have a varnished finish which peels or becomes cracked (or the wood itself, may be cracked). A split or rough handle on a tool is annoying to work with and is more likely to cause blisters than a smooth handle. Paint and varnish remover will do the fastest and most complete job of removing paint or varnish from wood handles. Follow instructions for each brand of remover and make sure to remove all traces of the remover before applying a new finish. Before refinishing glue together any broken or cracked parts and fill holes and cracks (plastic wood or water putty work well). Then sand the handle to a smooth finish. If you want to restore the handle to the original finish, paint or varnish as was previously done. Remember that two thin coats of paint or varnish (allow to dry overnight between coats) are better than one thick coat. If you want a finish that can be done very smoothly, can be renewed from time to time, and is actually polished with use, use boiled linseed oil. Linseed oil may be applied and rubbed in as the finish deteriorates whereas cracked paint or varnish must be completely stripped and re-done. Apply a coat of linseed oil to the wood and rub in with small pieces of Wetordry sandpaper (use #180 with the first coat, #280 with the second coat, and #320 or #400 with the third coat). You may not need three coats if the wood is already quite smooth. Re-apply coats of linseed oil as required.

If handles are badly cracked or broken (beyond repair) they should be replaced. Hardwares either stock or will order new parts such as saw handles, chisel handles, bolts, nuts, etc. Broken plastic handles can be glued and sanded smooth if not broken into small pieces.

Complete the following exercises and send them in for correction.

1. What effect will pitch on the base of a plane have on its operation?

____

____

2. You may have heard the expresssion "A place for everything and everything in its place". What are two things which can happen to tools if they are not carefully stored?

(a) ______________________________

(b) ______________________________

3. Why is it best to clean tools immediately after use instead of next time you want to use them?

____

____

____

4. What may be used to remove burned on plywood glue from a saw blade?

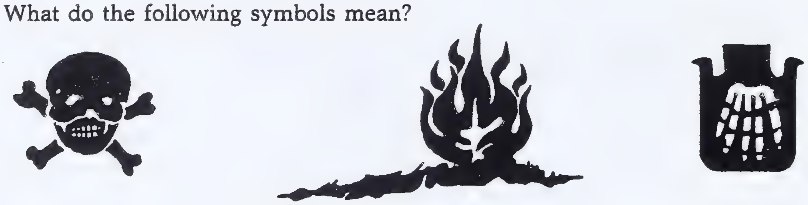
____

5. What is wrong with using gasoline to clean tools?

____

____

6. What do the following symbols mean?



__________ __________ __________

7. Which solvents, aside from water are safe to use?__________

8. Explain how you would clean rust from the grooves of corrugated plane base.

____

____

____

9. A coat of ________, rubbed into the markings on a steel square makes the markings more visible

10. Excess oil causes tools to pick up dust and dirt. However, some tools must be oiled. How do you solve this problem?

____

____

11. ________ ________ is a good finish to apply to wooden tool handles because the present linseed finish does not have to be removed in order to apply another coat of the same finish.

12. Which type of file is best to remove burrs from plane bases?

___

13. Why do steel tool heads stay on wooden handles after the handles have been wedged? Make a neat sketch to help you answer.

14. What is the procedure for putting a thin film of wax on a steel surface?

___

___

___

___

15. Describe how you would replace the neoprene rubber grip on a steel hammer?

___

___

___

___

___

16. Why should you be very careful when cleaning tools with a wire brush powered by an electric motor?

___

___

17. There are some surfaces on some tools which should NOT be covered with a thin film of wax. Name two.

18. After some use, the markings in a framing square become clogged and are hard to read. How do you fix this?

19. Below is a piece of plywood which is to be made into a tool panel. It is to be used to store a tape measure, a try square, a hand crosscut saw and a claw hammer. Draw these tools on the pannel board below.

20 Explain the procedure used to remove white glue from a plane base.

21. Why would you have to be very careful when cleaning tools on a wire brush mounted on a grinder?

END OF LESSON 4

BUILDING CONSTRUCTION 12

APPLICATION FOR WOOD SAMPLES AND SANDPAPER SAMPLES

(Wood Samples are needed for Lesson 12)

This application must be completed and returned with this lesson in order to receive the sandpaper samples needed in Lesson 10 and the wood samples needed in Lesson 12.

The wood sample kit is loaned to students for a maximum period of 2 weeks. They must be returned in good condition within this time period. There is a charge of $12.00 for lost or unreturned samples. Also do not throw away the carton the samples were mailed in. Use that carton to return the samples to the Alberta Correspondence School.

Sandpaper samples may be kept. They do not have to be returned to the Alberta Correspondence School.

Student's Name ______________________________

Student's File Number ______________________________

Student's Address ______________________________

____

Student's Signature ______________________________

Mail this application form to:

Alberta Correspondence School
Box 4000
Barrhead, Ablerta
TOG 2PO

Originated by:	Date:	Authorized by:	Date:
Input by:	Date:	Verified by:	Date:

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________

Time Spent on Lesson ____________

(If label is missing or incorrect)

File Number ____________

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received: ________

Lesson Recorded ________

Student's Questions and Comments

Apply Lesson Label Here

Name ________

Address ________

____

____

Postal Code ________

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

BORING AND DRILLING TOOLS

Boring Tools
Bits and Drills
Procedures

INTRODUCTION

The boring tools discussed in this lesson are gradually being replaced by electric tools.

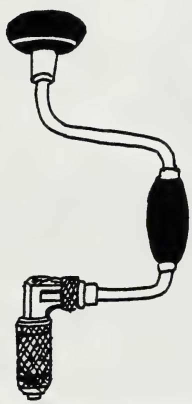
In many cases hand tools such as hammers, planes, handsaws, hatchets, screwdrivers, etc. are handier and faster to use than power tools. However this is not generally true of hand boring and drilling tools. They are used extensively only when there is no power available.

Bits and drills are used in most cases for both hand and power tool work.

BORING TOOLS

1. Bit Brace

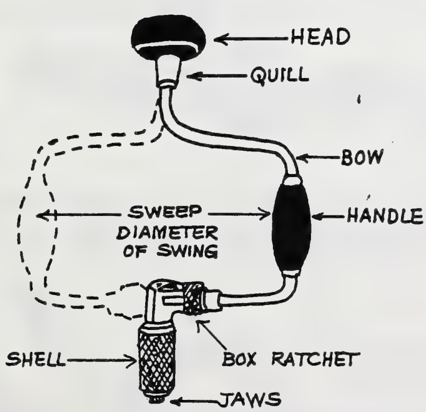
BIT BRACE

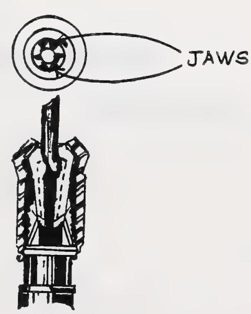


The bit brace is one of the most common and useful hand tools for holding and turning wood bits, countersinks, and large screwdriver bits. In fact they work on any bit with a square tang.

Bit braces are available with or without a ratchet device. The ratchet type is most common because it can be used in confined spaces where there is not enough room to make a full turn of the handle. The ratchet may be locked when it is not needed.

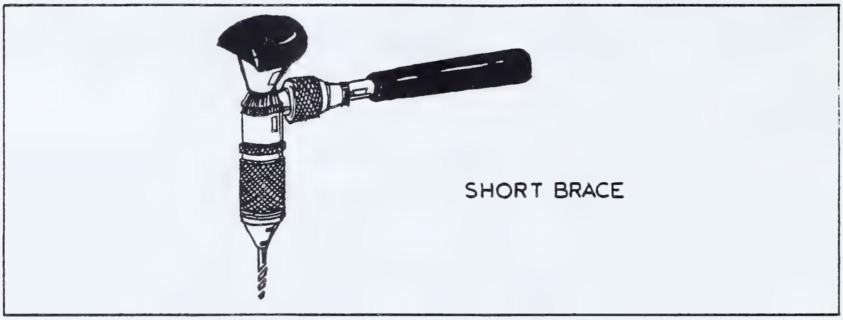
The 'sweep' is the diameter of the swing of the brace. The standard brace has a sweep of 25 cm. Bit braces are available with 30 to 36 cm sweeps which give more turning power.



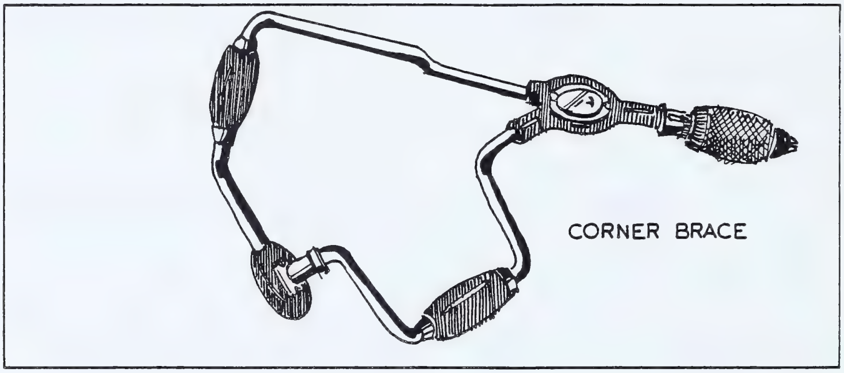


The chuck of a bit brace has two jaws, each of which has a square shaped groove in it to grip the corners of a square or 'tang' bit. A bit brace will not properly grip round shanked drills.

There are two other styles of braces. One of these is the short brace. It is especially designed to work in close quarters. (e.g. book shelves).

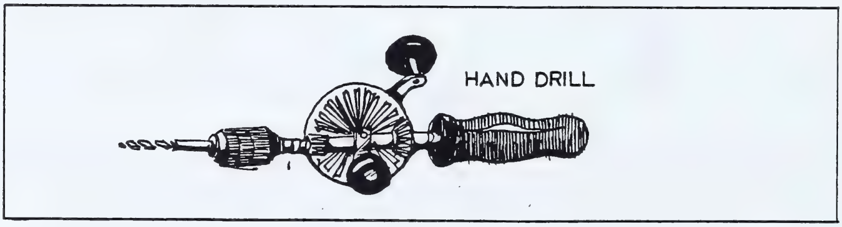


The other type of bit brace is the corner brace. It is ideal for boring in corners and against walls and beams.



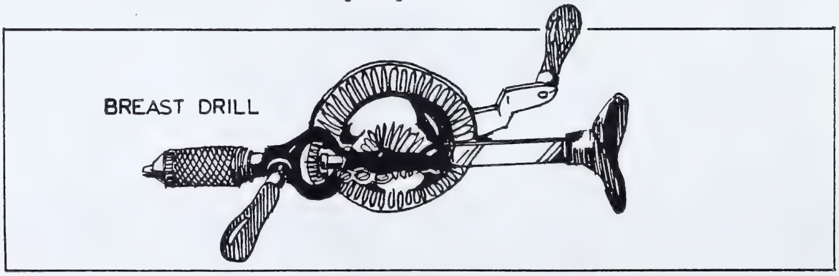
2. Hand Drills

The hand drill is designed to hold and turn drills which have round shanks. They have chucks with three jaws which will centre round shanks. The jams also apply more pressure on the drill to prevent slippage. They have been largely replaced by portable electric drills.



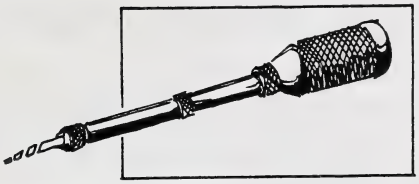
3. Breast Drills

The breast drill is very similar to the hand drill except that it is designed for heavy duty work (you push on it with your chest). Generally hand drills are limited to 6-8 mm capacity chucks while breast drills have 13 mm capacity chucks.



4. Push Drills

Push drills are handy for cabinet work where hinges and brackets must be held in place with one hand leaving the other hand free to operate the drill. Be careful not to lean from side to side as you drill because the small drill points break very easily.

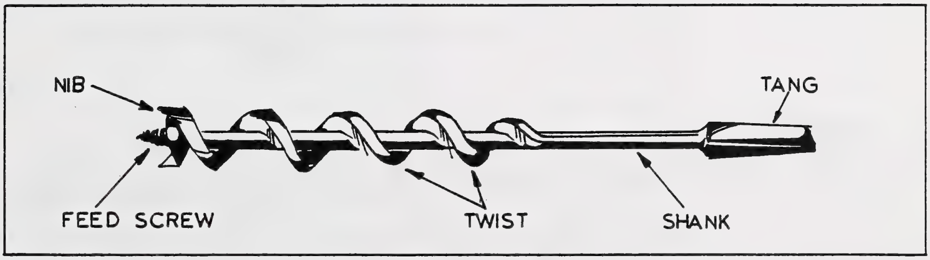


Push drills are almost indispensable when installing base board, door and window casings, quarter round, core and other finish moldings which split easily when nailed. There should be pilot holes drilled before nailing. They are also very useful for drilling pilot holes for screws.

BITS AND DRILLS

1. Auger Bits

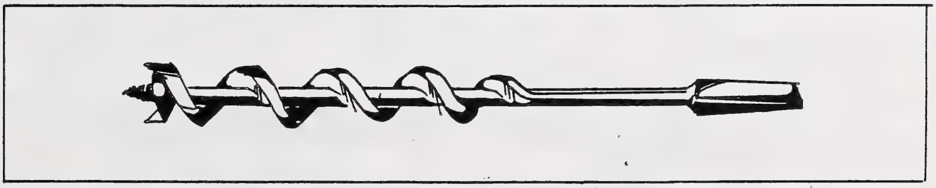
These are the most commonly used hand tool bits for boring holes from 6 mm to about 25 mm diametres. The auger bit has a square tang and is suitable for use in the bit brace. Square corners prevent slippage when heavy loads are applied to the brace.



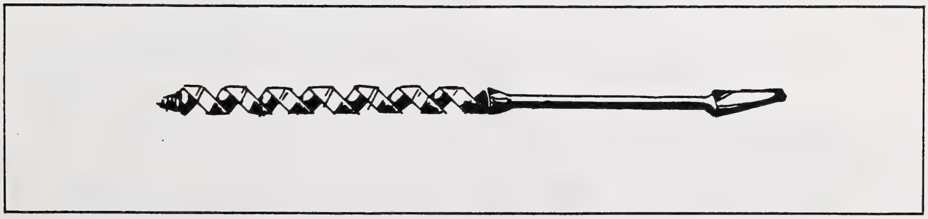
In general, auger bits are made in three lengths. The dowel bit is about 125 mm, the medium bit about 200 mm and the ship bit is between 450 mm and 600 mm long. The medium length is best for general carpentry.

There are three types of auger bits.

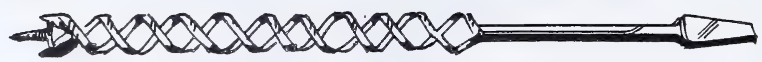
(a) The solid centre auger bit is the most common type used by carpenters. It is a strong durable bit. The solid center bit does, however, tend to pull itself into the work.



(b) The single twist auger bit is not as strong as the solid center auger bit but it has less of a tendency to pull foward into its work.

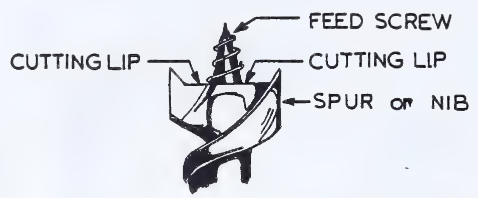


(c) The double twist auger bit bores more slowly. However, as it has two augers, the double twist auger bit cuts more slowly and accurately than the other two types of auger bits. It also leave a smoother surface on the sides of the hole.



Auger bits are available with fine, medium and course feed screws. The medium type feed screw is used for general carpentry work. For fast rough cutting in soft lumber the coarse feed scew could be used. For slow smooth cutting in hardwood and other materials, the fine feed screw would be best to use.

PARTS OF THE HEAD



2. Twist Drills

Twist drills available in drill indexes (boxes) which have drills sized from 1 mm to 13 mm in increments of 1 mm. The high speed steel drills are the best as they can be used to drill both wood and metal. When drilling holes in metal, centre punch an indentation in the work so the drill will not wander.

3. Expansive Bits

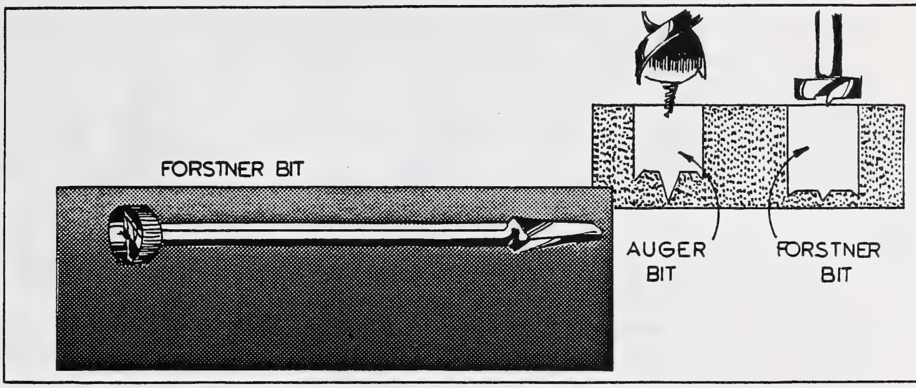
Expansive bits are commonly used to bore holes larger than 25 mm in wood. They are used in conjunction with a bit brace.

The standard expansive bit is supplied with two cutters (16 to 45 mm and 22 to 76 mm) but other sized cutters are available for boring holes from 13 mm to 127 mm in diameter.

One frequent use for the expansive bit is for boring a hole in the face of a door to take the lockset.

4. Forstner Bits

The forstner bits are very useful when a hole must be bored very close to the finished surface. They have a very short cutting spurs and no feed screw to protrude through the work. The hole, however, should be started with an auger bit as the forstner bit may not start properly and may wander from side to side.



5. Countersink Bits

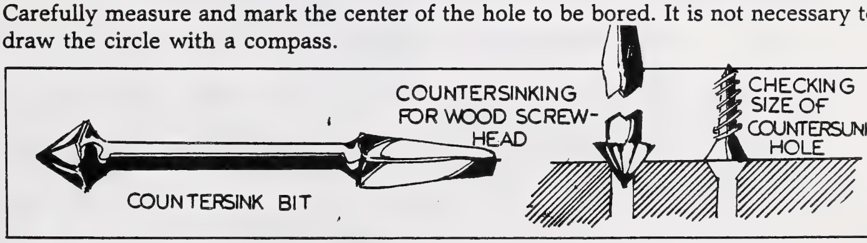
Counter sink bits are used when you want to set a flat head wood screw flush with the surface of the material. The shank hole should be drilled before using the countersink as the tip of the countersink does not cut.

Countersinking can be checked by turning the screw upside down and testing the countersunk size. Do not make the countersink hole to large as the screw head will pull down slightly as it is tightened-especially in softwoods.

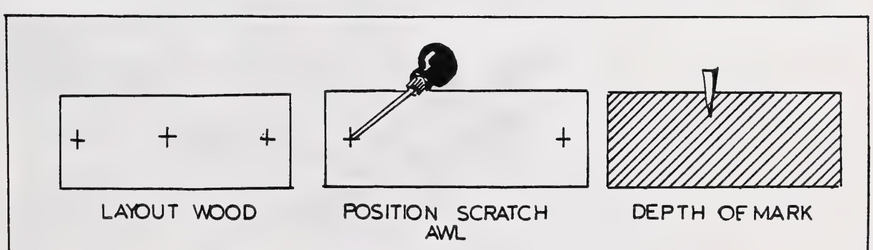
PROCEDURES

1. How to Bore Holes With Wood Bits

(a) Carefully measure and mark the center of the hole to be bored. It is not necessary to draw the circle with a compass.

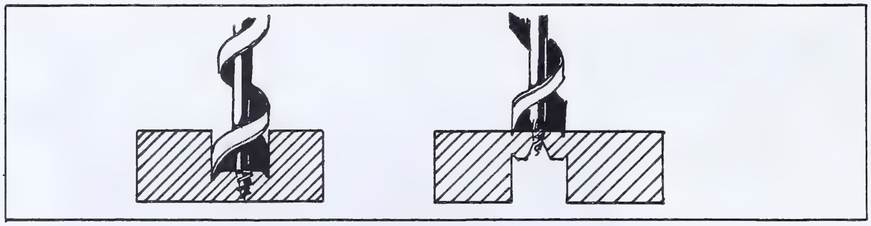


(b) Make a starting depression for centering the feed screw of the bit. This job can be done with a scratch awl.



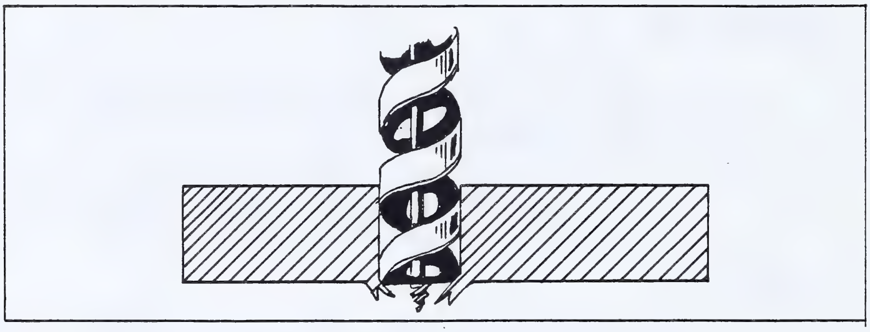
(c) Place the point of the feed scew in the depression. hold the bit at 90° to the work surface. A try square can be used to check when an accurate hole is required.

(d) Turn the brace clockwise until the point of the feed screw shows on the opposite side. If boring the hole becomes quite difficult, reverse the bit brace, and remove the bit from the hole. Clean any chips from the hole and carefully clean out the feed screw. Also check the bit for wood gum, tar, etc. and clean if necessary.



(e) Turn the wood around and place the point of the feed screw where it protruded from the back side. Pushing lightly, complete boring of the hole.

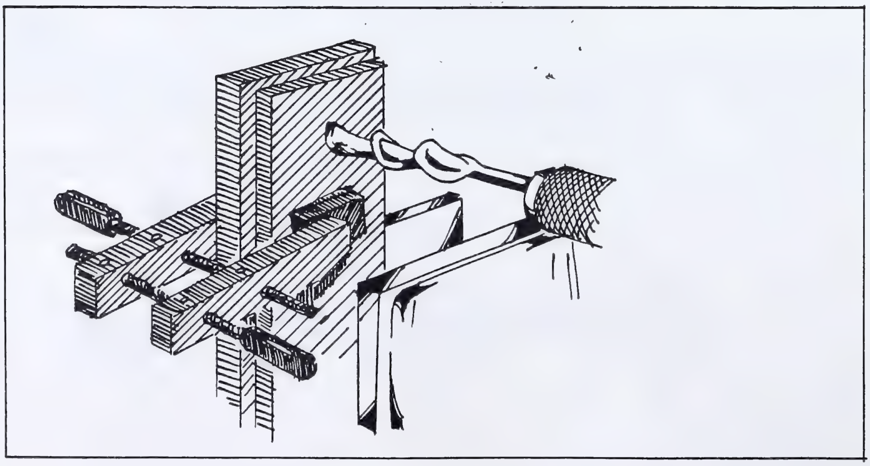
If you try to bore a hole all the way through the wood from one side, the wood will splinter on the opposite side.



2. An Alternate Method for Boring Holes with Wood Bits

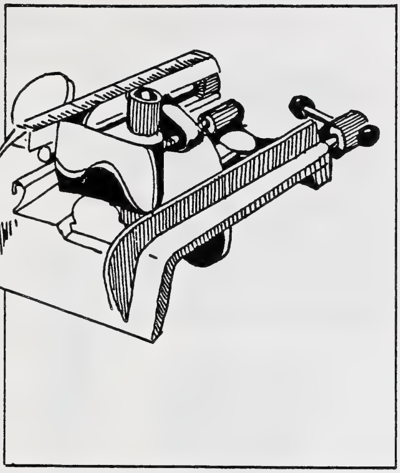
(a) Follow steps (a), (b) and (c) as explained under PROCEDURES section 1 above.

(b) Clamp a scrap piece of wood (one with a smooth face) tightly to the back of your good piece of material. This scrapblock must be clamped tightly or chipping may still result. For this reason clamping in two places is recommended.



(c) Bore the hole all the way through the good material. There should be no chipping at all where the bit leaves the good material and enters the scrap.

3. Using a Doweling Jig

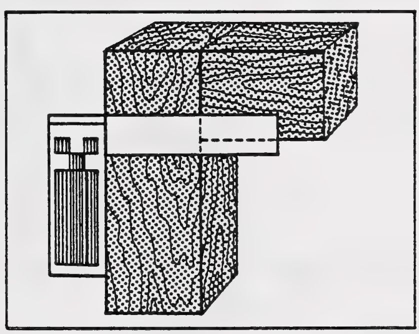


Dowels are small cylindrical pieces of wood used to give extra strength when joining two pieces of wood together. Half of the dowel goes into one of the pieces to be joined and the other half of the dowel goes into the second piece. See the diagram at the top of page 8. Dowels also help align the two pieces of material during final assembly.

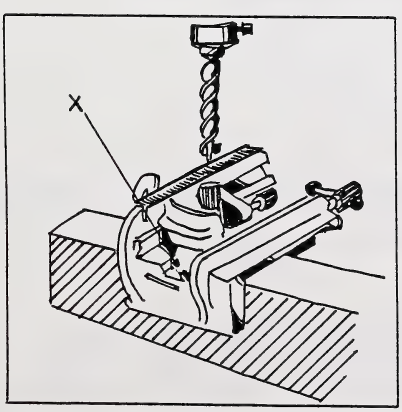
A doweling jig is used to guide an auger bit when great accuracy is required for matching dowel holes. Holes bored at a certain distance from an edge can be duplicated on another edge merely by transferring the jig. Guides are available for bits from 4.8 mm to 19 mm. The jig will clamp onto wood up to 73 mm wide. A doweling jig is used whenever dowel joints are made.

The procedure for using a doweling jig is as follows.

(a) The only layout required is a VERY accurate marking of the centers of the holes to be bored.



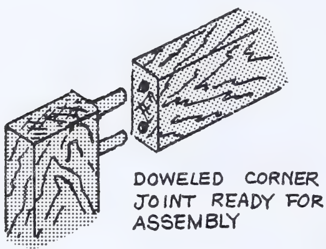
(b) The doweling jig is then centered on the layout marks. See point 'x' on the drawing. The doweling jig itself has to be adjusted so the bit will bore the hole in the centre of the board.

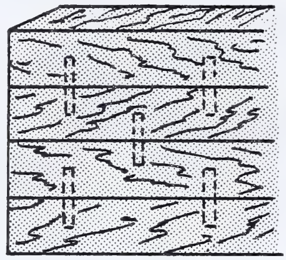


The bit is now inserted into the guide. Make sure it does not hit the edges of the guide, as it will be nicked. You are now ready to bore a hole. A depth stop or gauge will be necessary.

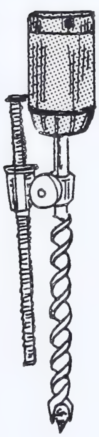
(c) Once one hole is complete, slide the dowling jig to the next mark, clamp it, and make the next hole

(d) Once all of the holes have been bored, the joint is ready to assemble. This tool is especially useful when doweling edge to edge joints in making breadboards, drafting table tops, coffee tables, etc, from pieces of lumber.

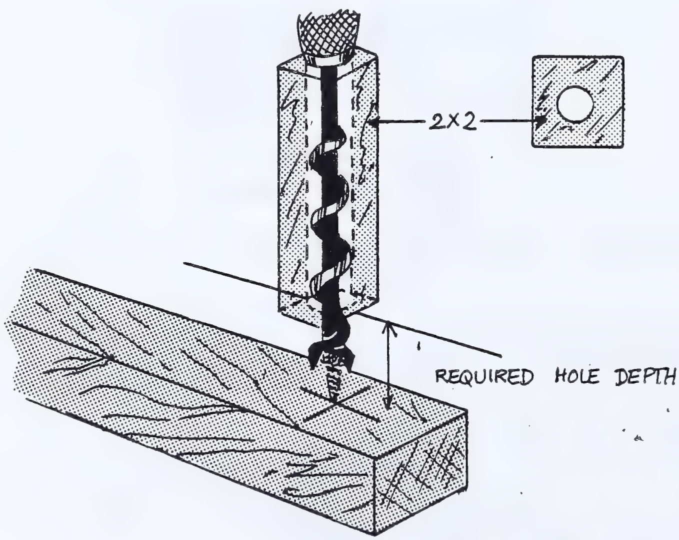




4. Depth Gauges



Depth gauges can be attached to wood bits and countersinks when several holes of a specified depth must be bored. You can make your own depth gauge by using a short piece of wood. Bore a hole through the wood and then cut it off to allow the required depth of hole.



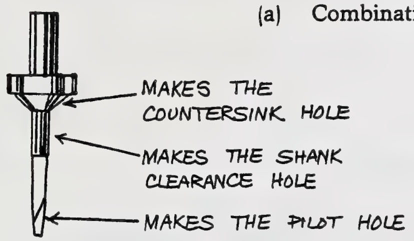
Depth gauges can also be purchased. These types are adjustable to an entire range of bit sizes and hole depths.

5. Combination Drills

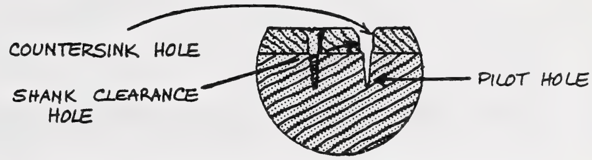
These drills make the pilot hole, the shank clearance hole and either the countersink or counterbore in one operation. These are different sizes to match different sizes of wood screws. They can be used with a hand drill or a power drill.

There are three types:

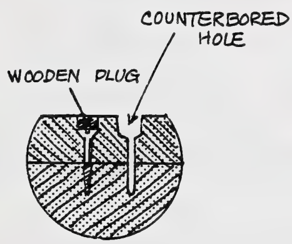
(a) Combination Wood Drill and Countersink



This bit drills the pilot hole, the shank hole and countersinks, all in one operation.

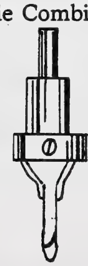


(b) Combination Wood Drill, Countersink and Counterbore



This bit does all the jobs listed in (a) plus in counterbores the holes so that the head of the wood screw will be below the surface of the wood. This hole is filled with a wooden plug glued in place to conceal the wood screw.

(c) Adjustable Combination Drill



This is a bit which can be adjusted to do the job of both the combination wood drill and countersink plus the combination wood drill, countersink and counterbore.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. Why is it preferable to buy a brace with a ratchet in it?

____

____

____

2. Which tool would you use to hold and turn auger bits? ______________

3. Auger bits are made with a square ____________ so that they will not turn in the chuck.

4. The pitch of the feed screw determines the ______________ of the cut.

5. A ______________ bit leaves a hole with a smooth, flat bottom.

6. Describe how to drill a hole through a board with a twist drill so that the hole does not chip out on the back side.

____

____

____

7. A counter sink can be used to drill so that screw heads drive in level with the surfaces of material. Two other drills that drill the pilot hole, countersink, etc. in one operation are the ____

_______________________ and the _______________________

8. A ____________ ____________ or a ____________ ____________ can be used to hold and turn twist drills.

9. If you were building some cabinets and had to install four hinges, what type of hand drill would you use and why?

____

____

____

____

10. What type of bit would you use to bore a hole in a door to take a lockset?

____

11. Describe how you would drill 80 holes in a piece of lumber, with each hole having to be exactly 40 mm deep and 25 mm in diameter. (Draw a diagram with your explanation.)

12. Suppose you had to drill a 5 mm deep hole in a piece of iron 9 mm thick. How would you do it and what tools would you use?

____

____

____

13. Auger bits come with various feed screws. What types would you select for boring holes in hardwoods? Why?

____

____

____

14. Why is it not necessary to draw a circle before starting to bore a hole?

____

____

____

15. Why is it best to use dowels when fastening several boards together to make a table top?

____

____

____

16. What is the complete name for the drill used to make holes in iron?

____

17. I am building a boat that will require approximately one thousand 75 mm screws. After the screws are put in, the heads will be covered with dowel plugs. What type of bit would be best for this job?

____

18. You are boring a hole through a piece of wood. What will happen if the scrap board clamped to the back of your project is not clamped tight?

____

____

____

19. What is the advantage of using a doweling jig to make holes for dowels?

20. You have to fasten a wooden block to the underside of a table top and have to install a wood screw through the top of the table to hold it in place. How would you do this so the wood screw would not show? What tools are necessary?

EXERCISE 2

List any specific areas that you have found hard to understand in the lessons to this point.

END OF LESSON 5

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________________

Time Spent on Lesson ____________________

(If label is missing or incorrect)

File Number ____________________

Lesson Number __________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ______

Date Lesson Received: ____________________

Lesson Recorded ______

Student's Questions and Comments

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ALBERTA CORRESPONDENCE SCHOOL

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1. **BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:**

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. **POSTAGE REGULATIONS**

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. **POSTAGE RATES**

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Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

ASSEMBLY AND HOLDING TOOLS

Hammers
Nailing
Nails
Screwdrivers
Wood screws
Clamps

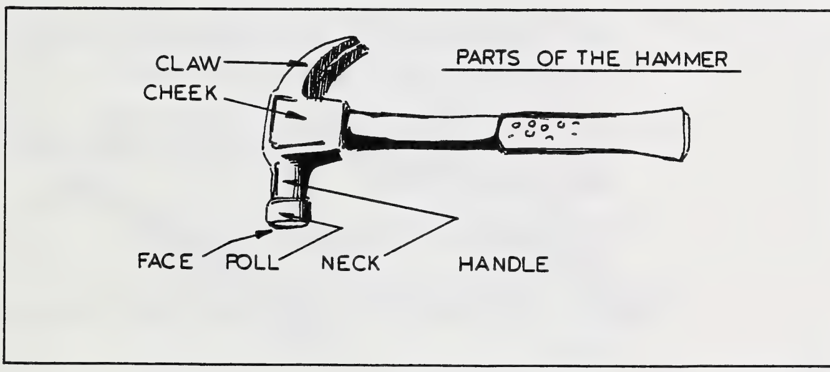
INTRODUCTION

A top quality job of layout marking, cutting, and planing can be ruined by improper use of assembly and holding tools. Hammer marks, a scratch where the wrong size of screwdriver slipped, vise or clamp marks, or a gouge where a panel was slid into a saw horse, all lead to a poor looking project. For top quality work learn how to properly use the holding and assembly tools. Take time to be careful.

HAMMERS

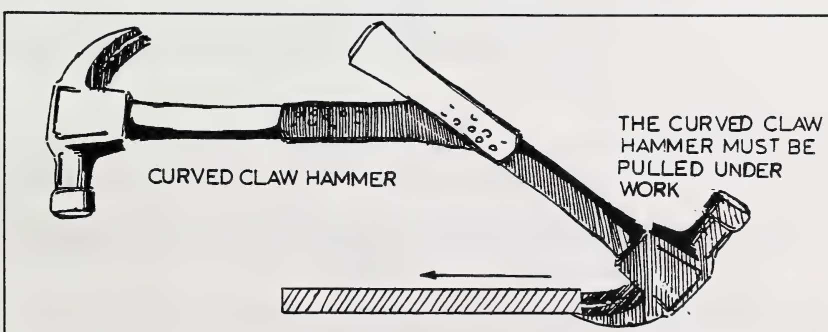
1. Claw Hammers

Claw hammers are available in 198, 283, 369, 454, 567 and 794 gram weights. The 198 to 369 gram sizes are referred to as finishing hammers. The 454 to 567 gram sizes are general purpose hammers. Those hammers heavier than 567 grams are framing hammers.

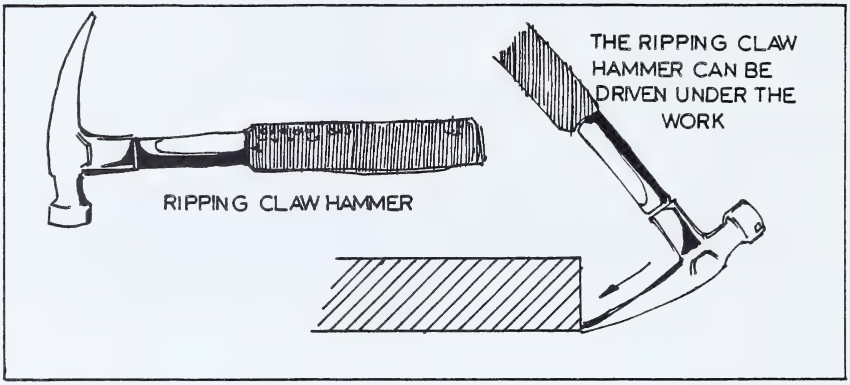


Claw hammers come in two styles:

(a) The curved claw hammer gives more leverage for pulling nails as the head does not touch the wood as quickly. However, it is difficult to place the curved claw hammer under a board when removing it.



(b) The straight claw or ripping claw hammer works better than the curved claw hammer for removing boards as the claw can be driven under the board. The shock of the wedge shaped claw driving under the block will usually start removal of the block.



The disadvantage of the ripping claw hammer is that it does not pull nails as well as the curved claw hammer since the entire head touches the work immediately decreasing leaverage.

Claw hammer heads are made with two different shapes of hitting ends (faces).

(a) The plain-faced (flat) hammer is easier to use as it does not tend to glance off the nail head easily but it does tend to leave more hammer marks on the wood than the bell-faced hammer. The plain-faced hammer is used for general construction.

(b) The bell-faced hammer will tend to glance off the nail easier until one is used to using it, but you can pound a nail flush with the surface of the work without leaving hammer marks.

Claw hammers can have three types of handles.

(a) Wood handles absorb the most shock. Carpenters tend to like them for this reason. They will not however take the abuse of pulling large nails or exposure to weather.

(b) Steel handles are a lot less likely to break than wooden handles. They usually have a neoprene rubber grip. This makes it less likely that the hammer will slip out of your hand in cold weather.

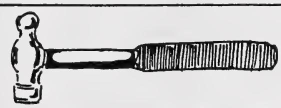
(c) The fiberglass handles are less likely to break and have a neoprene rubber grip.

If the face of a hammer gets pain, grease, tar, etc. on it, the hammer will slip off the nail very easily. To cure this, rub lightly with fine sandpaper until the dirt is removed.

2. Other Hammers

Claw hammers should not be used when pounding on cold chisels and solid objects or for chipping concrete. The shock of the hammer hitting solid material may break the claw. Also claw hammers are difficult to use when installing small nails. There are several hammers to do these jobs.

(a) The ball peen hammer is used for general purpose pounding on cold chisels or other metal or concrete objects. They are available in several sizes from approximately 340 g to 900 g.

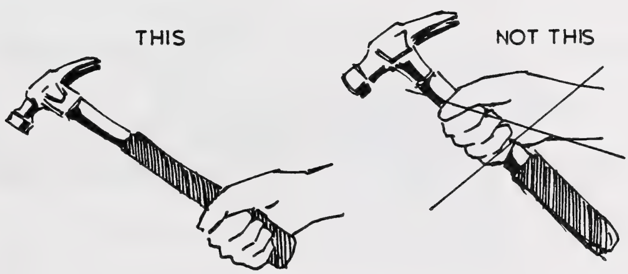


(b) The sledge hammer is available in weights of 3.6 kg or more and is used for heavy duty work on wood, metal, or concrete. Protect your eyes from chips when using a sledge hammer.

(c) The last hammer type to be discussed is the tack hammer. These are very light hammers and are used for installing brads (small-finishing nails). A tack hammer has a magnet installed in the head so the nails will stick to it. This makes it easier to install the brads with less finger damage.

NAILING

Remember when nailing -- the hammer has a weighted head so swing smoothly and let the hammer head drive the nail. If you swing very hard you lose accuracy and bend nails or leave hammer marks. Swing by bending at one or all of the wrist, elbow and shoulder depending on how heavy the blow is to be.



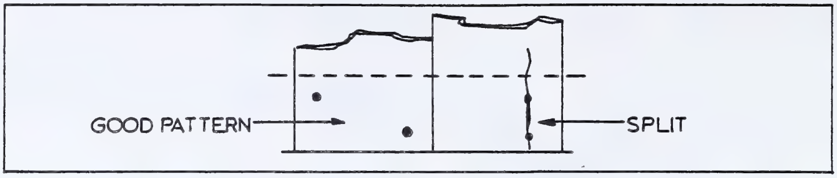
The hammer should be gripped near the end of the handle for maximum driving efficiency (if it was designed to be held in the middle, the handle would be made 180 mm long instead of 330 mm). Choking up on the handle reduces the power of your stroke and increases the chance of missing the nail.

1. Nailing Procedure

(a) Nail from a thin piece of lumber into a thicker piece. The nails will have more holding power.

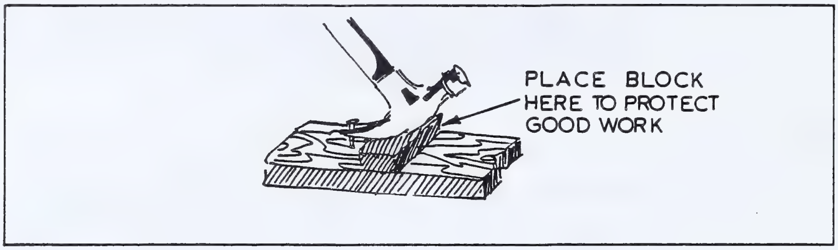
(b) If possible, drive nails across the grain rather than into end grain. Nails have much less holding power in end grains.

(c) Do not drive nails in line with each other down the grain of lumber, especially near the end of a board -- it will split! Stagger the nails.

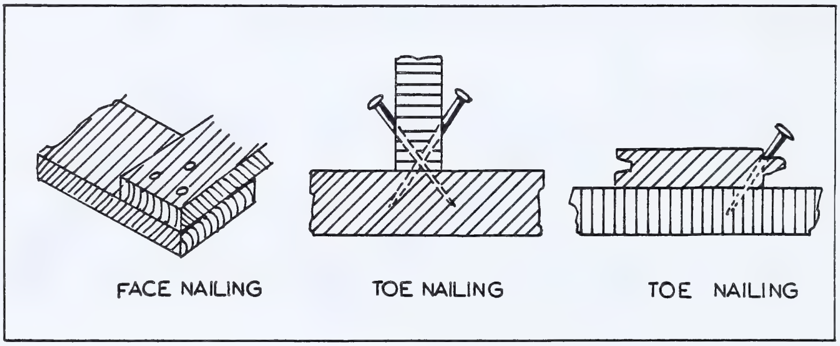


(d) Where there is danger of splitting, drill a hole slightly smaller than the nail (e.g. in fir door or window casings or baseboard).

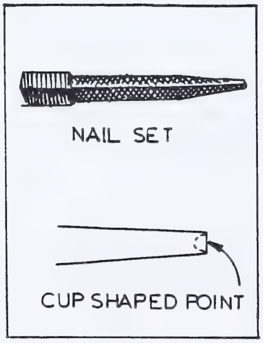
(e) When pulling a nail out of finish material use a block under the hammer so it does not mark the finish. It is also easier to pull out the nail.



Most nailing is either face nailing or toe nailing. All framing in a house is done by one of these two methods.



2. Concealing Nails



Nail sets are used to set finishing nails below the surface of the wood. The nails are pounded in so that the top of the head is 1 to 2 mm below the wood surface. The existing hole is then filled making the nail invisible to sight.

Nail sets are not punches and should not be used as a general purpose punch. Nail sets have an end which is cupped inwards whereas a punch has an end which is flat. The end of a nail set is cupped so it does not slip off the head of a finishing nail and mark the wood.

Nail sets are available in sizes from about 1 mm to 4mm.

NAILS

When a nail is driven, wood fibers are bent down or broken off and jammed between the nail and other unbroken wood fibers. Most of the withdrawal resistance of a nail in wood results from this jamming and wedging action. Other fibers, forced aside

as the nail enters the wood, exert a squeezing action, thus increasing the friction between the nail and the wood.

The shape and texture of the nail shank affect the degree of fiber distortion and hence the holding power of a nail. Various shank types and coatings have been devised to increase withdrawl resistance.

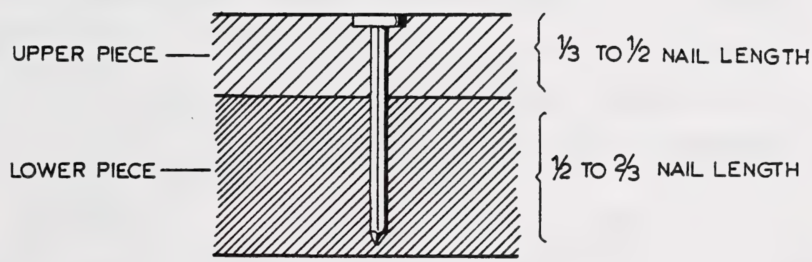
Nails, however common they may be, often present a confusing picture because of the great variety available.

Nails and spikes are manufactured in many lengths, diameters, types, materials, and finishes, each with a different use in mind.

1. Nail Lengths

One of the criteria for determining the size of a nail is its length. Nails are available in lengths from 12 mm to 355 mm.

As a general guideline for choosing the correct length of nail for fastening two pieces of material together, ⅓ to ½ of the nail length should be used by the first or top board and the other ½ to ⅔ should enter the second board.



2. Nail Types

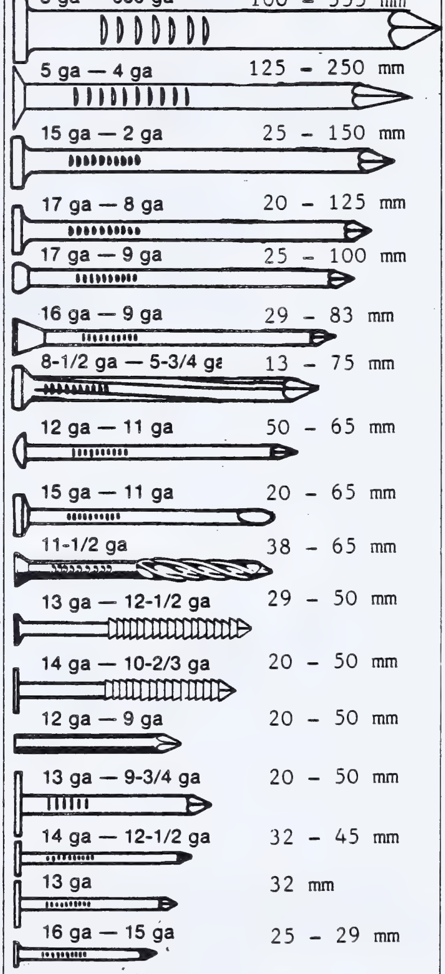
Long common nails (100 mm and longer) are usually refered to as spikes. A spike is used to fasten heavy pieces of timber together.

Shorter standard or common nails are used in general construction whereas box nails are used in light construction, household use, or assembly of boxes. Box nails have a smaller shank diameter than the same length of common nail would have.

For a complete list of nail types, heads, shanks and points available refer to the chart on next page.

TABLE 1 Types of Nails

Type of Nail	Head	Shank	Point	Material	Finishes and Coatings	Size: Diameter	Size: Length
Common (Spike)	F	C,S	D	S,E	B	3 ga — 000 ga	100 - 355 mm
Eavestrough (Spike)	Cs,F	C,S	D,N	S	B,Ghd	5 ga — 4 ga	125 - 250 mm
Standard or Common	F	C,R,S	D	A,S,E	B,Ge	15 ga — 2 ga	25 - 150 mm
Box	F,Lf	C,R,S	D	S	B,Pt,Ghd	17 ga — 8 ga	20 - 125 mm
Finishing	Bd	C,S	D	S	B,Bl	17 ga — 9 ga	25 - 100 mm
Flooring and Casing	Cs	C,S	Bt,D	S	B,Bl,Ht	16 ga — 9 ga	29 - 83 mm
Concrete	Cs	S	Con, Bt,D	Sc	Ht	8-1/2 ga — 5-3/4 ga	13 - 75 mm
Siding and Clapboard	F,O	C,S	D	A,S	B,Ghd	12 ga — 11 ga	50 - 65 mm
Clinch	F,Lf	C,S	Db	S	B	15 ga — 11 ga	20 - 65 mm
Hardwood Flooring	Cs	S	Bt	S	B,Ht	11-1/2 ga	38 - 65 mm
Gypsum Wallboard	Dw,F	C,R,S	D,N	S	B,Bl,Ge	13 ga — 12-1/2 ga	29 - 50 mm
Underlay and Underlay/Subfloor	F,Cs	C,R	D	S	B,Ht	14 ga — 10-2/3 ga	20 - 50 mm
Roundwire Sash Pins	—	C	D	S	B	12 ga — 9 ga	20 - 50 mm
Roofing	Lf,F	C,R,S	D	A,S	B,Ghd	13 ga — 9-3/4 ga	20 - 50 mm
Wood Shingle	F	C	D	A,S	B,Ghd	14 ga — 12-1/2 ga	32 - 45 mm
Gypsum Lath	F	C,S	D,N	S	B,Bl,Ge	13 ga	32 mm
Wood Lath	F	C,S	D	S	Bl	16 ga — 15 ga	25 - 29 mm



How To Use Tables

1. Determine the types of material to be fastened, magnitude and kinds of loads, exposure (interior or exterior), appearance requirements and the quantity of nails needed to do the job.
2. Use the National Building Code of Canada and/or the Residential Standards as a guideline to determine required lengths, numbers and spacing of nails. Where codes do not cover requirements, calculate number and size of nails using design procedures in this publication.
3. Select a nail type, size, style, material and finish that will do the job properly. If the job cannot be done with standard types consult a manufacturer. Keep in mind that special nails may be available economically for large orders, but for small orders selection may be restricted to stocks carried by retail lumber and hardware stores.
4. For standard nail dimensions, refer to CSA Standard B111 *Wire Nails, Spikes, and Staples* and to manufacturers' product literature.
5. Abbreviations used in tables are relevant to this Datafile only.

3. Nail Shanks

Nail shanks are made smooth or deformed. The deformed shank is usually spiral or ringed.

For fastenings of a temporary nature, smooth shanked nails should be used. They can be withdrawn without damaging the wood.

Spiral nails are permanent fasteners. They provide greater holding power especially against shock loads. They are also easier to drive than common nails and reduce wood splitting.

Ring-threaded (annular) nails provide the highest holding power of any nail. They are not suitable for shock loads that cause partial withdrawal of the nail as the threads tear the wood as the nail is withdrawn.

4. Nail Points

There are four basic types of nail points. They are the diamond, blunt diamond, long diamond, and duckbill nail points.

The most common nail point is the diamond point. This one is easy to drive and gives good holding power. The long diamond is easiest to drive but may cause splitting when used in harder woods. The use of the blunt diamond reduces splitting but slightly decreases holding power. Any nail can be purposely blunted to help reduce splitting.

Duckbill points are not as common but are occasionally used for clinching to increase resistance to withdrawal.

5. Materials Nails are Made From

Nails can be made of mild steel, high-carbon steels, aluminium, copper, brass, bronze, stainless steel, or monel. Some of these may have to be specially ordered and are more expensive than ordinary mild steel nails.

High carbon steel nails are stronger than the same size mild steel nails. Hardened nails are used for special jobs such as nailing into concrete. See chart on next page.

6. Nail Coatings

Special coatings are applied to nails to increase holding power, improve corrosion resistance, or improve the appearance.

Nails can be plated with cadmium, brass, bronze, copper, chrome, or nickel to improve appearance and corrosion resistance.

Nails can also be phosphate coated (phoscoated). These replace the cement coated nails fomerly used and offer improved holding power under repeated loads.

Galvanizing is a process where hot zinc coatings are applied to steel. The hot dipped galvanized nails are used outdoors where good corrosion resistance is required. This treatment gives a rough finish and is not usually suitable for ring nails. Electrogalvanized nails have a thinner zinc coating and are used for interior work where corrosion is not usually a serious problem.

TABLE 2 Heads, Shanks and Points

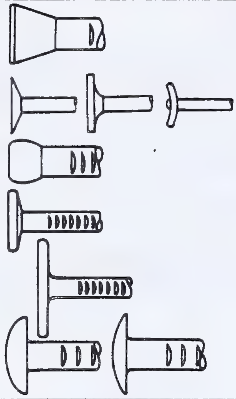
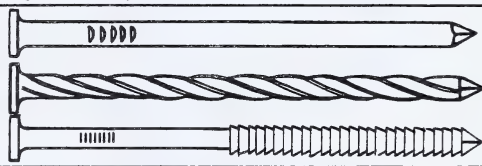
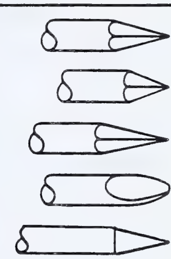
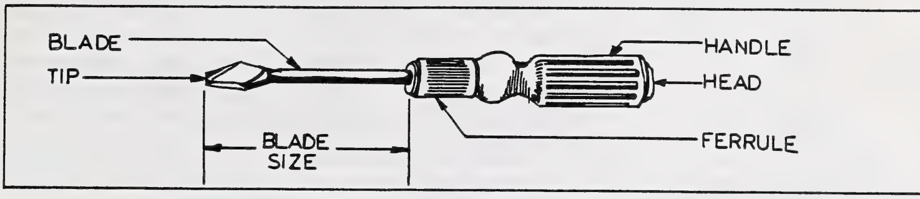
	Type	Abbrev.	Remarks	Illustration
Heads	Flat Counter-Sink	Cs	For nail concealment; light construction, flooring, and interior trim.	
	Drywall	Dw	For gypsum wallboard.	
	Finishing	Bd	For nail concealment; cabinetwork, furniture.	
	Flat	F	For general construction.	
	Large Flat	Lf	For tear resistance; roofing paper.	
	Oval	O	For special effects; siding and clapboard.	
Shanks	Smooth	C	For normal holding power; temporary fastener.	
	Spiral (or Helical)	S	For greater holding power; permanent fastener.	
	Ringed	R	For highest holding power; permanent fastener.	
Points	Diamond	D	For general use, 35° angle; length about 1.5 x diameter.	
	Blunt Diamond	Bt	For harder wood species to reduce splitting, 45° angle.	
	Long Diamond	N	For fast driving, 25° angle; may tend to split harder species.	
	Duckbill	Db	For clinching small nails.	
	Conical	Con	For use in masonry; pen-trates better than diamond.	

TABLE 3 Materials, Finishes and Coatings

	Type	Abbrev.	Remarks
Materials	Aluminum	A	For improved appearance and long life; increased stain and corrosion resistance.
	Steel-mild	S	For general construction.
	Steel-high-carbon hardened	Sc	For special driving conditions; improved impact resistance.
	Stainless steel, copper and silicon-bronze	E	For superior corrosion resistance; more expensive than hot-dip galva-nizing.
Finishes and Coatings	Bright	B	For general construction; normal finish; not recommended for exposure to weather.
	Blued	Bl	For increased holding power in hardwood; thin oxide finish produced by heat treatment.
	Heat treated	Ht	For increased stiffness and holding power; black oxide finish.
	Phoscoated	Pt	For increased holding power; not corrosion resistant.
	Electro-galvanized	Ge	For limited corrosion resistance; thin zinc plating; smooth surface; for interior use.
	Hot-dip galvanized	Ghd	For improved corrosion resistance; thick zinc coating; rough surface; for exterior use.

SCREWDRIVERS

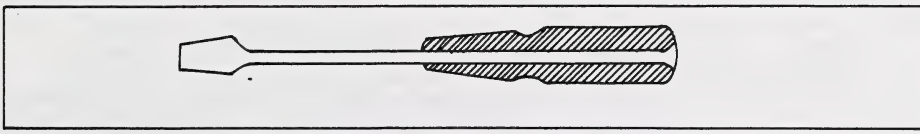
Screwdrivers are available in a variety of styles, tip shapes, blade lengths, and blade widths.



1. Handles

Handles are made of either wood or plastic. Some plastic handles have a rubber grip bonded onto them.

On some screwdrivers the blade runs completely through the handle. The reason for this is so one is able to pound on them without damage to the handle. Although screwdrivers are not intended for pounding on, some people do it.

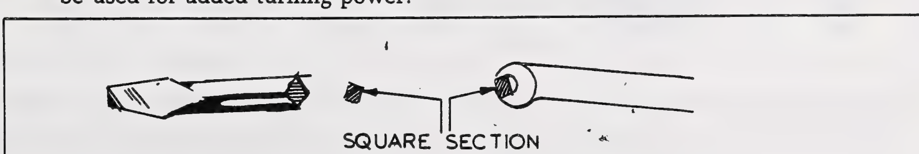


Handles on other screwdrivers have the blade inserted only part way into the handle. This type should not be pounded on very hard.

The size of the handle is designed to suit the screwdriver blade. A small screwdriver only requires a small handle since a small wood screw requires only a small amount of force to install it. Large wood screws, on the other hand, require greater force to install and hence a larger screwdriver handle is necessary. A small wood screw can be easily twisted off or the threads stripped in the wood by using too large of a screwdriver on it.

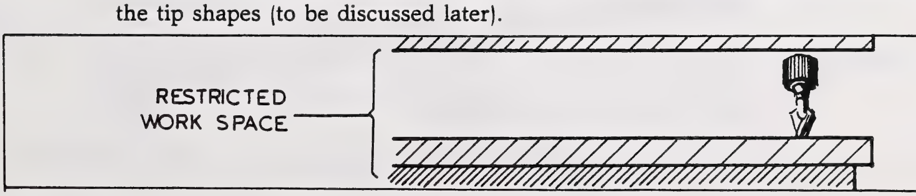
2. Shanks

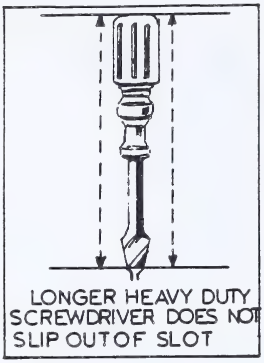
(a) The shank of most standard and light duty screwdrivers are round. On heavy duty screwdrivers however, the shank is often square so that an open end wrench may be used for added turning power.



(b) There are several different lengths of screwdrivers depending on their size and on which of the three categories of screwdrivers they belong to. The three categories are:

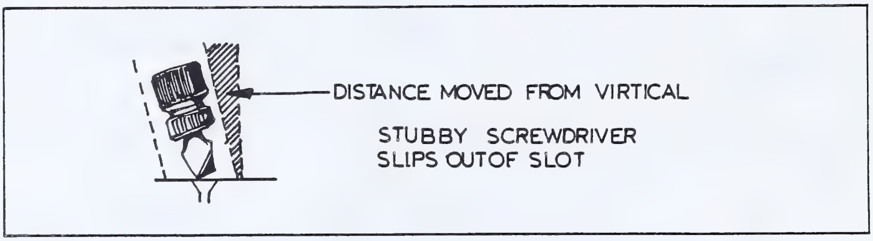
(i) Stubby screwdrivers. These are used when installing wood screws in restricted places. Their overall length is 90 mm. They are available in any of the tip shapes (to be discussed later).





(ii) Standard screwdrivers. These are available in any of the three tip shapes and are up to about 30 cm long.

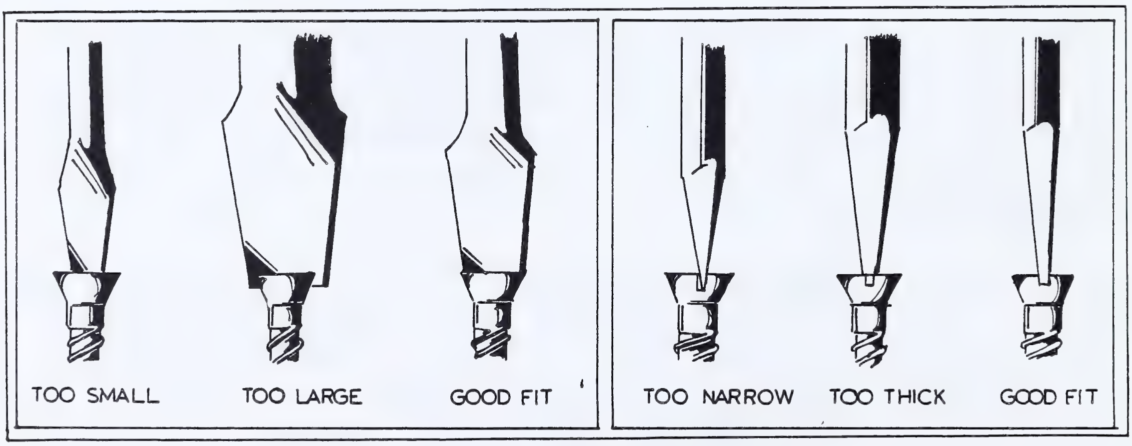
(iii) Heavy duty screwdrivers. This category has lengths of blades up to 50 cm. They are available with standard (slot) tips. The longer the blade on a screwdriver, the easier it is to keep the screwdriver in the slot of the wood screw. The reason is that with a short stubby screwdriver it does not take much of a sideways movement of the handle before the screwdriver blade is at too great an angle to stay in the slot.



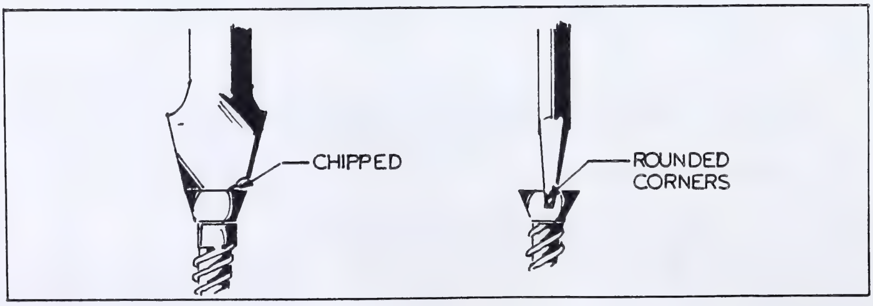
3. Types of Screwdriver Tips

There are three common screwdriver tip shapes.

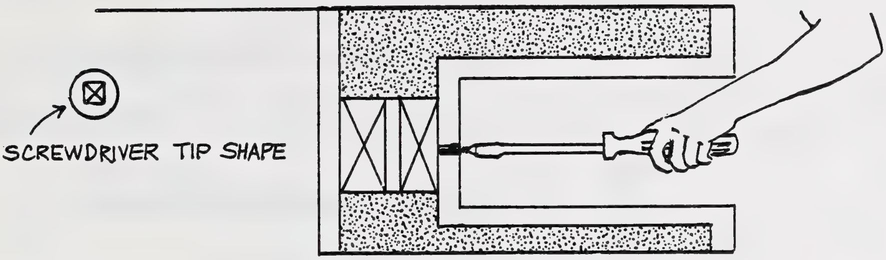
(a) Slot tips (also called standard) are the oldest and most common types. They range from the very small jewellers screwdrivers to the cabinet, the standard, and the wide, thick heavyduty tips. It is especially important that the screwdriver fit the screw slot accurately, otherwise the screwhead becomes damaged quite quickly.



The screwdriver bit should be straight and square, not rounded and (or) chipped. Rounded tips slip easily and damage screw slots and possibly the wood itself.



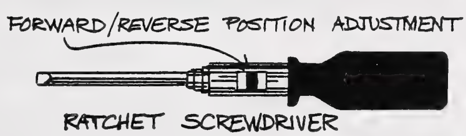
(b) Robertson (socket) tips are in the form of a square. The screwdriver does not slip sideways out of the screw head like a slotted screwdriver does. The screws will stay on the end of the screwdriver by themselves so that you can reach into a deep hard to get at place with one hand and install the wood screw.



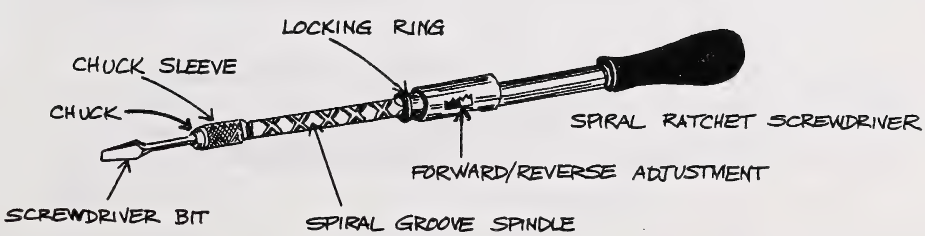
(c) The phillips tips are in the form of a star or cross. The screwdriver does not slip sideways out of the slot as easily as the standard (slot) type. This is especially important when using air or electric tools, such as the dry wall screwdriver. As with other screwdrivers, the size is given by the length of the blade and the size of the tip.

4. Special Screwdrivers

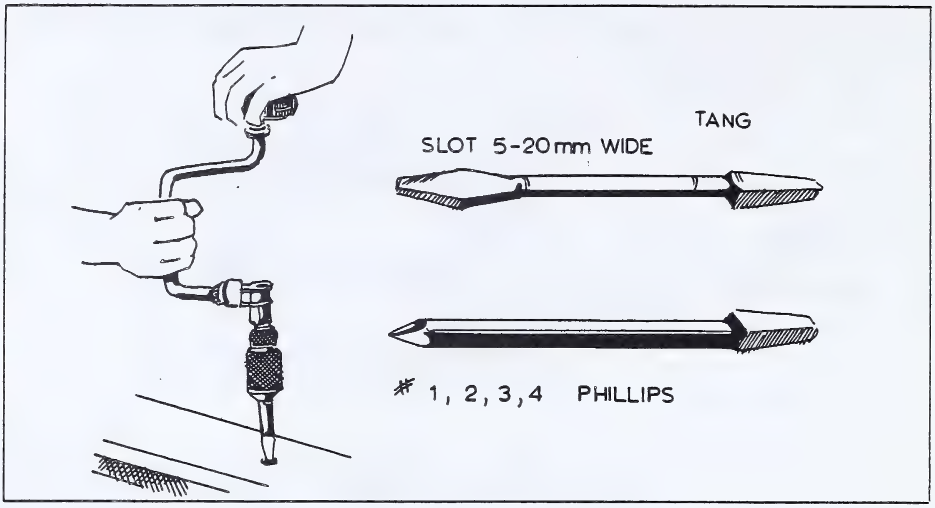
(a) Ratchet screwdriver. With a ratchet screwdriver you do not have to keep moving your hand on the handle to drive a screw. The ratchet allows you to drive a screw by turning the handle back and forth. The handle drives one way and will coast when moved the opposite way. This is the same principle that a ratchet in a socket set uses.



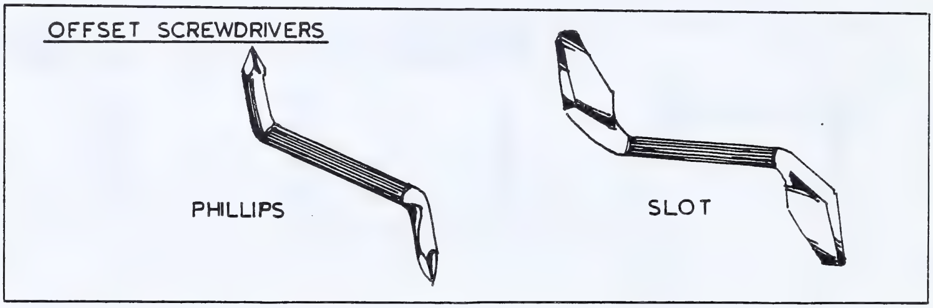
(b) Spiral ratchet screwdrivers. When this screwdriver is in the extended position, pushing on the handle turns the sprial grooved spindle and drives the screw as the screwdriver length shortens. Most of these screwdrivers have a spring in the handle that automatically returns the screwdriver to the extended position.



(c) Bit brace. For extra heavy duty work and large screws, a screwdriver bit placed in a brace adds leverage. Several sizes of bits are available for a brace.



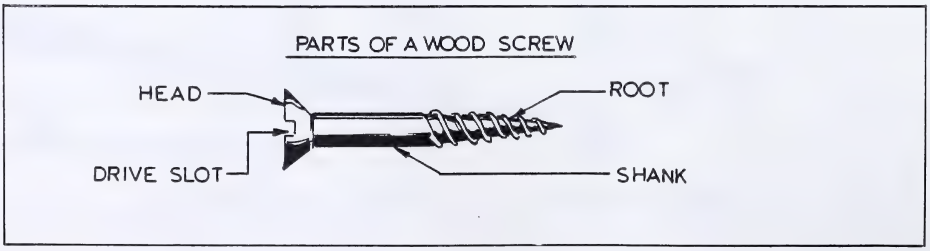
(d) Offset screwdrivers. These are especially useful when installing wood screws in places which do not have enough room to use a conventional screwdriver.



WOOD SCREWS

After nails, wood screws are the next most common fastening device. They are specified by the shape of their head, type of drive slot, diameter (gauge number), the metal from which they are made, (brass, bronze, steel) and the coating (if any) on them.

Wood screws have several advantages over nails. One of the main advantages is that wood screws have greater holding power than nails in wood. Another advantage is that wood screws can be removed easily without fear of damaging the wood. A third plus for wood screws is that they can be removed and then reinstalled in the same hole without losing holding power. With nails, once they are removed they will have very little holding power if they are reinstalled in the same hole.



Wood screws are not as commonly used as nails because of several disadvantages. One of these is the cost. Wood screws cost many times more than nails. Another disadvantage is that it takes more time to install wood screws than to put in nails. A third disadvantage is that wood screws require more equipment to install them nails.

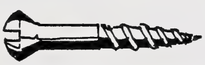
1. Types and Sizes of Wood Screws

(a) Common wood screw head shapes

(i) Flat head wood screws are the most commonly used wood screw. They are used where a flat surface is necessary. The top of the head should be even with the surface of the wood when properly installed.

They are also used when the wood screw must be sunk below the surface of the wood and covered with a plug.

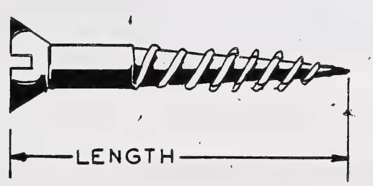
(ii) Round head wood screws are usually used to fasten metal brackets to wood. With the round head wood screw you do not have to countersink a hole to fit the head. As the head sits above the wood, round head screws cannot be used in areas where the heads may interfere with other components of the project.



(iii) Oval head wood screws are used where the heads will show and a decorative finish is desired. They may also be chosen as their head strength is greater than the flat head wood screw. This is due to the increased head size.

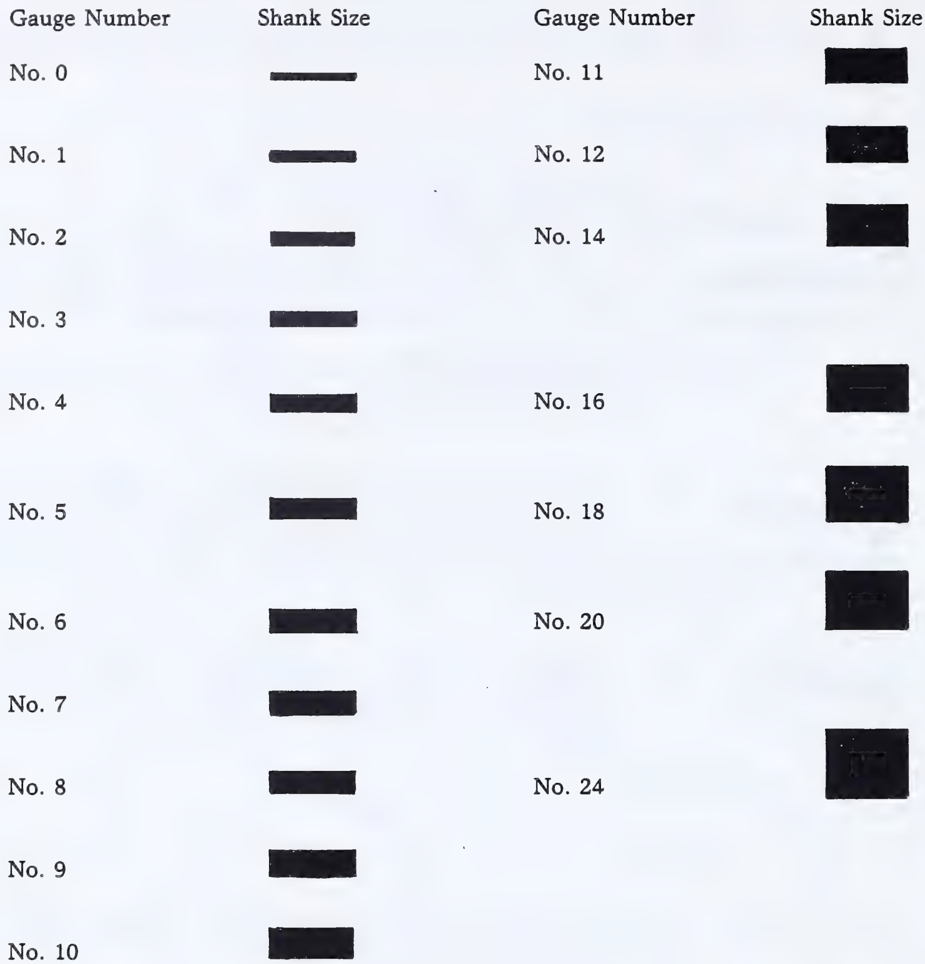
(b) Length of wood screws.

Wood screws are available in lengths from 6 mm to 150 mm. The length is measured from the portion of the head which will be flushed with the surface of the material to the tip of the root.



(c) Gauge of wood screws.

Wood screws vary in the size (diameter) of the shank and root. This diameter is expressed as the gauge. Wood screws vary from 0 gauge, which is the smallest, to 24 gauge, which is the largest. Below is a chart giving the actual wood screw shank size. To determine the size of a wood screw visually, lay the screw shank on the silhouette.



Not all of the wood screw lengths are available in all of these gauges. For example, 25 mm flat head wood screws are available in guages from 4 to 12 whereas 50 mm flat head wood screws are available in gauges from 8 to 16.

2. Installation Procedures for Wood Screws

(a) Introductory information

Before getting into proper installation procedures for wood screws we should take a look at several important points concerning wood screws.

The purpose of the head is to pull inward on the top piece of material. An example of this would be the head of a wood screw pulling a hinge tight to the wood. The threads do not (and should not) cut into the top piece of material. When fastening two pieces of wood together the same idea applies. The head pulls on the top piece of wood.

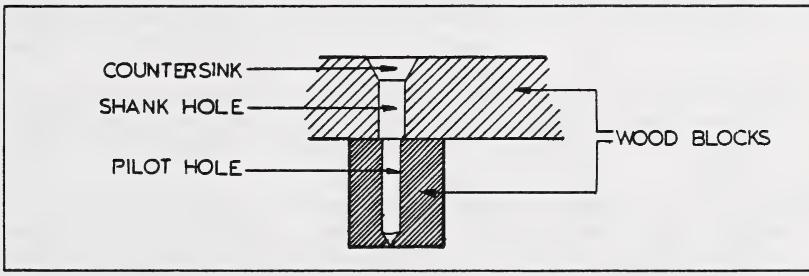
The purpose of the threaded portion (root) of a wood screw is to cut into the wood fibers (of the second or lower board) instead of pushing them aside as nails do. This is what gives wood screws their greater holding power.

You may have heard some people talk about pounding in wood screws. This is NOT a correct procedure. Wood screws which have been pounded in do not have any more holding power than ring nails and ring nails are much cheaper.

How do you properly install wood screws? Below is a description of the best way to install wood screws in order to get good strength and avoid splitting the wood, stripping the screw slot, or twisting off the screw.

(b) Drilling holes for wood screws.

The proper installation procedure involves drilling holes as shown below.



(i) The shank hole should be the same size as the shank diameter of the wood screw. This is so the screw will slide into the hole. The screw should, however, fit snugly. The fact that the wood screws slides into the shank hole will save a lot of effort as it won't have to be turned in using a screwdriver.

(ii) The purpose of the pilot hole is to guide the wood screw in straight and to make the wood screw easier to install.

The size of the pilot hole is determined by the root diameter of the wood screw. The root diameter is the diameter of the solid shaft measured at the bottom of the threads. For hardwoods the pilot hole should be the same size as the root diameter of the wood screw and as deep as the wood screw will go into the wood. For softwoods the pilot hole should be approximately 15% smaller than the root diameter and only ¾ the depth the wood screw will go into the second piece of wood.

Boring Chart for Wood Screws

In selecting a tool size for the pilot hole (for threaded-portion of screw), note that the root diameters are average dimensions measured at the middle of the threaded portion. On some screws the root diameter tapers slightly from the end of the screw, increasing toward the head. It is usually good practice to bore the pilot hole the same size as the root diameter in hardwoods, such as oak, and about 15% smaller for softwoods, such as pine and Douglas fir. In some cases, allowances can be made to take advantage of moisture content and other varying factors. This same rule can be used for shank holes. The SHANK DIAMETER shown are standard specifications

subject to tolerances of $\begin{matrix}+0.10 \text{ mm} \\ -0.18 \text{ mm}\end{matrix}$. MAXIMUM HEAD DIAMETERS shown below are standard specifications which apply to flat and oval-head screws. Head sizes run 5% to 10% smaller for round-head screws.

Gauge No. of Screw	Maximum Head Diameter	Shank Diameter		Root Diameter		Pitch in mm	Gauge No. of Screw
		Basic Size	Recommended Drill Size (mm)	Average Size in mm	Recommended Drill for Hardwood (mm)		
0	3.0	1.5	1 or 2	1.0	1	.79	0
1	3.7	1.9	2	1.2	1	.91	1
2	4.4	2.2	2	1.4	1	.98	2
3	5.1	2.5	3	1.7	1 or 2	1.06	3
4	5.7	2.8	3	1.9	2	1.15	4
5	6.4	3.2	3	2.2	2	1.27	5
6	7.1	3.5	4	2.4	2	1.41	6
7	7.8	3.8	4	2.6	2 or 3	1.59	7
8	8.4	4.2	4	2.8	2 or 3	1.69	8
9	9.1	4.5	5	3.1	3	1.81	9
10	9.8	4.8	5	3.3	3	1.88	10
11	10.4	5.2	5	3.5	3 or 4	1.95	11
12	11.1	5.5	6	3.7	3 or 4	2.31	12
14	12.5	6.2	6	4.2	4	2.54	14
16	13.8	6.8	7	4.7	4 or 5	2.82	16
18	15.2	7.5	8	5.2	5	3.17	18
20	16.5	8.1	8	5.7	5 or 6	3.18	20
24	19.2	9.5	10	6.6	6 or 7	3.63	24

*Pitch is the distance between threads.

(iii) The last step is to countersink or counterbore the hole. Countersinking means making the top of the shank hole conical in shape so that it matches the shape of the underside of the screw head. This is done for flat head and oval head wood screws only. The countersink bit was discussed in lesson 5.

(c) Procedure for installing wood screws.

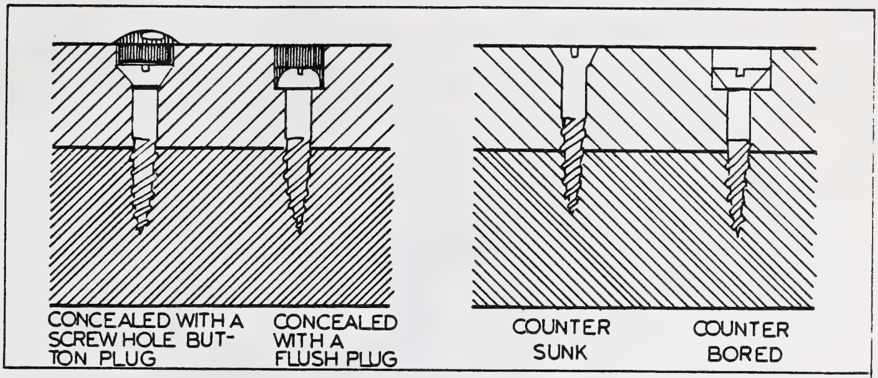
(i) Mark the location of the hole with a light pencil (+). You need only mark the center with two lines. You do not have to draw a circle. Set a hole where the two lines cross with a scratch awl. This will keep the drill from wandering off center.

(ii) Select the correct gauge and length of wood screw. The length should be chosen so that approximately ⅓ of the wood goes into the first board and ⅔ goes into the second board (where the pilot hole is made).

(iii) Drill the shank clearance hole the same diameter as the shank diameter of the wood screw. The shank hole is normally drilled completely through the first piece of wood.

(iv) Mark the location of the pilot hole. One way to do this is to take a scratch awl, place it into the shank hole and make a small mark into the second board. Drill the pilot hole the same size as the root diameter of the wood screw if you have a hardwood or 15% smaller if it is a softwood. Drill the hole as deep as the screw will go if you have a hardwood and only ¾ of the depth if softwood is being used.

(v) Countersink or counterbore if required.
Counterboring is done so that a screw head can be concealed or set lower into the wood to allow a shorter wood screw to be installed.



(vi) Select the proper size and type of screwdriver for the wood screws you are using and turn them in clockwise. Twist until the screw seated firmly otherwise it may be twisted off or the threads stripped in the wood.

If screws are driving too hard (especially in hardwood) you could rub some paraffin wax (which will not stain the wood) or soap onto the screw threads. If this does not help much, you could drill the pilot hole larger.

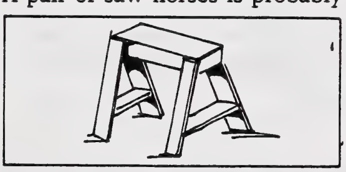
(vii) If the screws are too large for driving with an ordinary screwdriver, us a large bit and a bit brace. This will give a great deal of added leverage. Be careful to just seat the screw firmly as increased leverage can lead to the breaking or stripping of the screw shank.

(viii) When using the spiral ratchet screwdriver, be sure that the bit is centered on the screw. Also, make sure you are lined up with the screw. If you are not, the screwdriver will slip and gouge the wood badly.

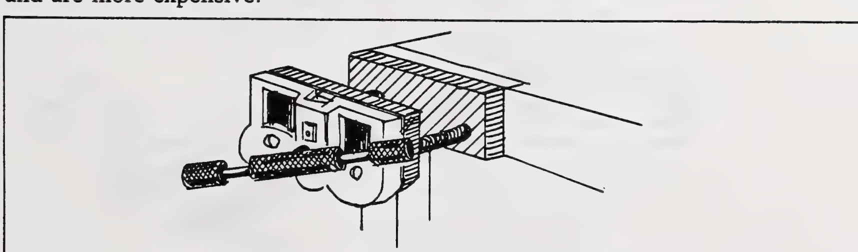
HOLDING TOOLS

Earlier in this lesson permanent types of fasteners were discussed. Carpenters do not always need permanent fasteners. There is at times a need to hold items as they are being cut, planed, or until glue sets. The following section will discuss these tools.

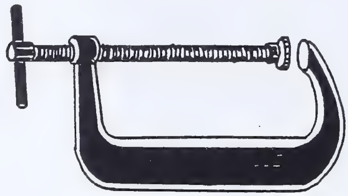
1. A pair of saw horses is probably the most common and useful holding device found on construction sites. They are quickly made and, if properly constructed, are strong and steady. They may be made completely of lumber or with saw horse brackets designed to hold wood legs and beams.



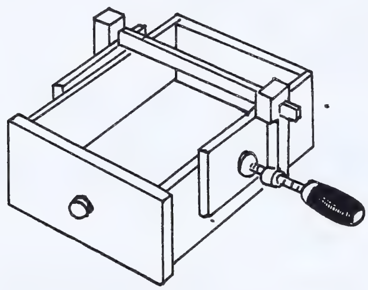
2. A Light Bench Vise is a useful holding tool which may be clamped to a bench or sawn horse. Heavier vises are available but are not nearly as handy and portable and are more expensive.



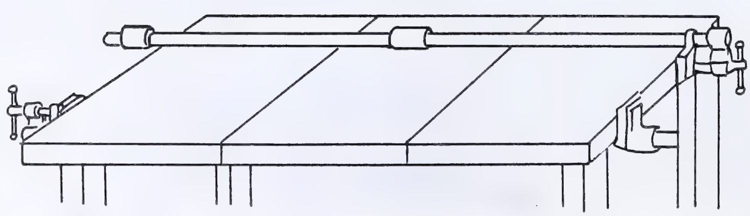
3. 'C' clamps are one of the most common and useful holding clamps. They vary in size from 25 mm up to 300 mm in opening. When clamping wood scrap pieces of wood are used under the jaws so that the finish wood is not marked.



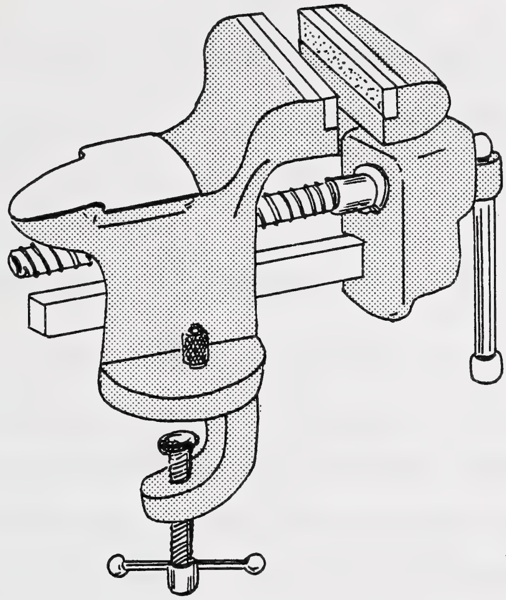
4. Bar clamps vary in size from about 15 cm opening to about 20 cm. They are quickly adjustable to a wide range of clamping widths.



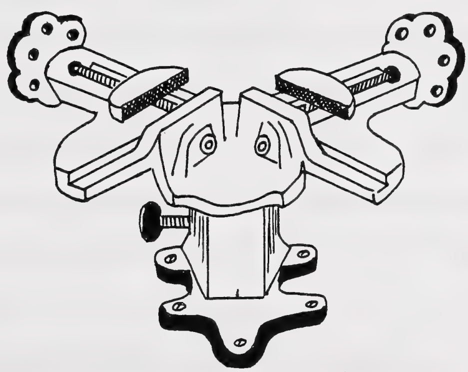
5. Pipe clamps to fit a 13 mm pipe and 19 mm pipe make possible clamps of almost any length, limited only by the length of pipe you buy.



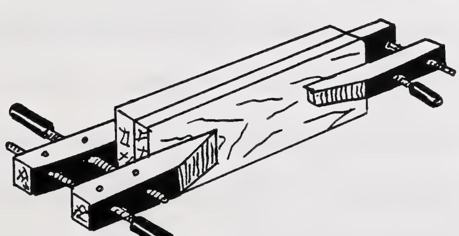
6. A metal-working vise is useful for holding metal material when hacksawing, filing, etc. The type shown may be clamped to a bench or sawhorse for shop or fieldwork.



7. The mitre vise is a special vise used to hold mitred joints while gluing and nailing a picture frame, or any small box or frame with mitred corners.



8. Hand screws are ideal clamps for wood as the jaws are broad and tend to distribute the clamping pressure over a wide area. The greatest pressure can be obtained by first tightening the inner screw and then the outer one.



9. A variety of other jigs and holding tools can be made such as the bench hook and coping saw jig (or V-block) as shown in lessons 2 and 4.

EXERCISE 1

Complete the following exercises and send them in for correction.

1. List the two styles of claw hammers.

   (a) ______________________________

   (b) ______________________________

2. Explain why a ripping claw hammer is better for removing braces than a curved claw hammer.

   ____

   ____

   ____

3. Explain why the curved claw hammer is the most commonly used hammer.

   ____

   ____

   ____

4. Why is a bell-faced claw hammer preferred by carpenters?

   ____

   ____

5. Why do beginners like the plain-faced claw hammer?

   ____

   ____

6. Why do carpenters prefer wooden handled hammers?

   ____

   ____

7. What are two advantages of fiberglass or steel handles?

   (a) ______________________________

   ____

   (b) ______________________________

   ____

8. What could possibly happen to a claw hammer if you try to pound a shaft out with it?

9. How can you protect the surface of a piece of work while removing a nail?

10. Why are finishing nails set?

11. Explain the general guide for determining the proper nail length to choose.

12. Why are ring nails not suitable for shock loads?

13. What type of hammer is best for installing small finishing nails or brads?

14. Which type of nail point gives the greatest holding power?

What is the disadvantage of using this point?

15. Why are some nails 'phoscoated'?

16. Driving several nails in a row down a board could cause the lumber to

____.

17. You may have seen a sided house wall or a fence where each nail left a strip of black running down from the nail head. What is the cause of this?

____

____

____

How can it be prevented from happening?

____

____

____

EXERCISE 2

1. What could happen to a small wood screw by using too large of a screwdriver?

(a) ____

(b) ____

2. Why does a heavy duty screwdriver always have a longer blade than a light duty one?

____

____

____

3. Name the three common screwdriver tip shapes. (a)____________________

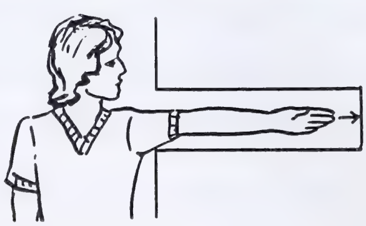
(b)____________________(c)____________________

4. What will likely happen if a screwdriver bit becomes rounded or chipped?

____

____

5. How would you install a screw in a place where you could barely reach with your arm? (see diagram below)



____

____

____

____

6. For a #8 screw to be turned into hardwood you should use a ________________ bit for the pilot hole and a ______________________________ bit for the shank hole.

7. If you keep applying pressure after a screw is seated firmly you may

____

8. Mr. Jones is building a house. He decides to use wood scews to hold the sheathing on the outside of the house. Although this may be stronger, list three reasons why this should not be done.

   (a) ____

   (b) ____

   (c) ____

9. What is the main advantage of choosing round head wood screws for placing brackets onto wooden boxes?

____

____

____

10. Wood screws have greater holding power than nails. Why?

____

____

____

11. It is unnecessary to draw a circle to locate the position of the hole to be drilled. Why?

____

____

12. Why would some people use a brace with a screwdriver bit to install wood screws?

____

____

13. Could you use ordinary screws for a boat?______________________________

Why?____

Would you recommend another type of screw, and if so, what kind?

____

____

EXERCISE 3

1. I want to glue some black walnut, but I'm afraid that the 'C' clamps I have will make marks in this very expensive wood. How can I clamp the wood without marking it?

____

____

____

2. Suppose you were driving screws in hardwood, and it is very very hard to turn them, what could you do? (name 3 things you could do)

(a) ______________________________

(b) ______________________________

(c) ______________________________

3. I'm building a bookcase out of 20 mm thick mahogany. What size and type of nails should I use?

Size ______________ Type ______________

Why would you use these nails? ______________________________

____

____

____

4. What would be the difference between a spike and a nail that are of the same length?

____

____

5. What is the difference between a box nail and a common nail?

____

____

END OF LESSON 6

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

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(If label is missing
or incorrect)

File Number

____

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned
Teacher: ________

Lesson Grading: ______

Additional Grading
E/R/P Code: ______

Mark: ________

Graded by: ________

Assignment Code: _____

Date Lesson Received:

____

Lesson Recorded _____

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ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

TOOL MAINTENANCE II

Sharpening plane irons
Sharpening auger bits
Renewing tools by grinding or filing
General maintenance

INTRODUCTION

As you learned in Lesson 3, a dull edge is not only inefficient but also dangerous. Therefore you should learn how to sharpen tools so they maintain a razor like sharpness.

Tools, other than cutting tools, must sometime be ground or filed to make them work properly (examples -- claws on nail hammers, screwdriver tips, scribers, scratch awls, bits, etc.). You should be familiar with some of the methods used to recondition these tools.

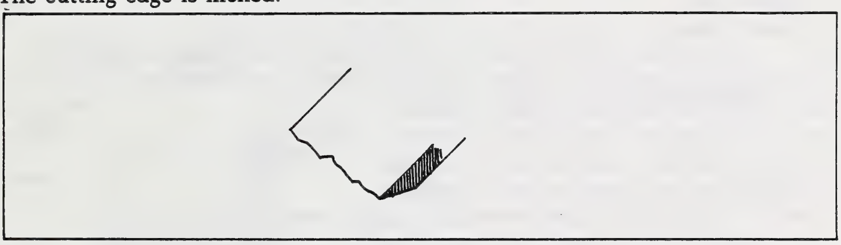
SHARPENING PLANE IRONS AND CHISELS

The sharpening of a plane iron involves three different operations. If these are carefully followed your plane iron or chisel should be sharpened to a razor sharp condition. These three operations are grinding, whetting, and honing.

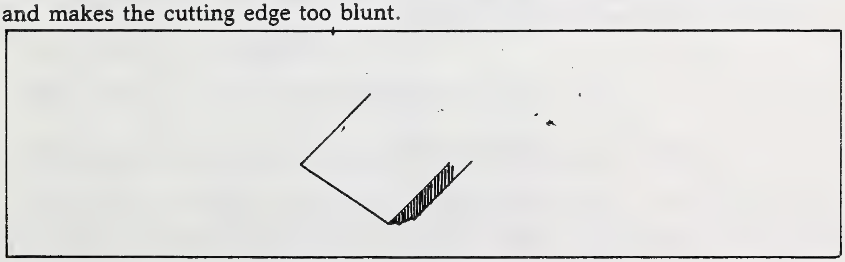
1. Grinding a Plane Iron

A plane iron or chisel requires grinding if it has one of the following three faults.

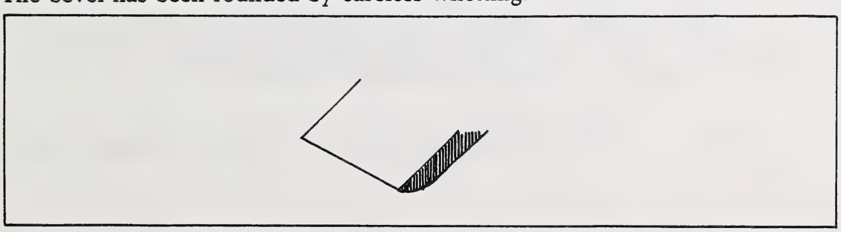
(a) The cutting edge is nicked.



(b) The bevel has been worn down by too much whetting. This changes the angle and makes the cutting edge too blunt.



(c) The bevel has been rounded by careless whetting.

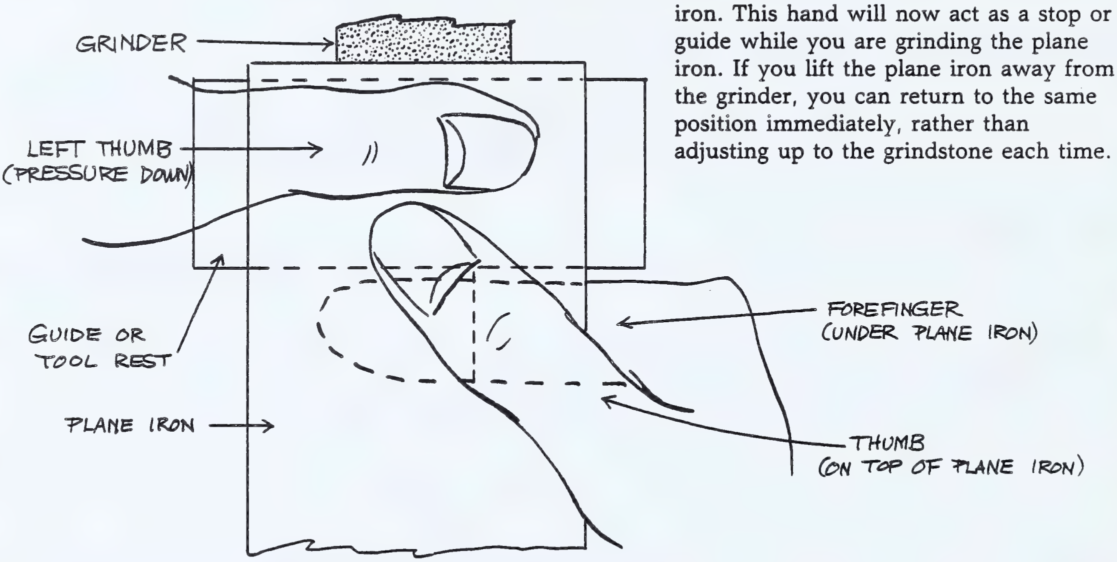


If the plane iron does not have one of these faults you can go to step 2. However, if it has one of these faults it must be ground. You can grind the plane iron on an electric grinder. For best results a fine grinding wheel should be used. If a grinder is not available you could try a single cut mill file. This file does not work as well as a grinder but if the file is sharp it will cut enough to shape the plane iron.

The steps necessary to grind the plane iron are listed below.

(a) The cutting edge of a plane iron is ground at a 25° to 30° angle. In order to get this angle the tool rest on the grinder must be carefully adjusted.

(b) Slide the plane iron (flat on the guide) until it touches the grindstone. Holding it in place with the left hand, slide the right forefinger (under the plane iron) up until it touches the guide. Pinch down on top of the plane iron. This hand will now act as a stop or guide while you are grinding the plane iron. If you lift the plane iron away from the grinder, you can return to the same position immediately, rather than adjusting up to the grindstone each time.

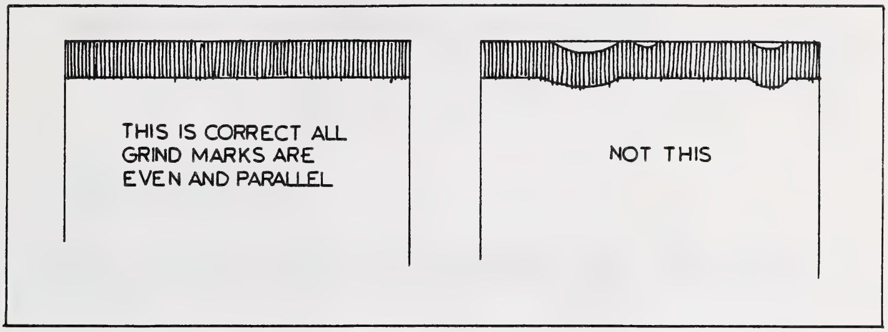


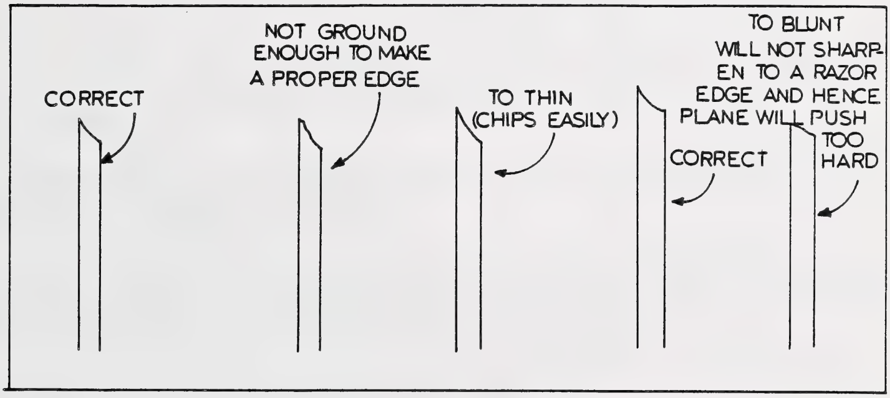
(c) Position the fingers of your left hand against the left side of the tool rest so that they cannot slip against the grinding wheel (you can be badly cut). Press down with your left thumb to hold the plane iron flat to the tool rest.

(d) Start the grinder and, using the above hand positions, slide the plane iron back and forth across the grinding wheel. Do not push too hard against the grinding wheel or hold the plane iron in one position too long, or you will 'burn' (turns blue-black) the plane iron and remove the 'temper' from the steel. (Steel is tempered by heating it and working it until it has the proper degree of hardness and toughness. Overheating a plane iron will remove this hardness and the plane iron will dull quickly in the future.)

(e) Dip the plane iron frequently into a can of cold water to cool it. Don't move the position of the right thumb and forefinger on the plane iron or you will have to re-position them each time.

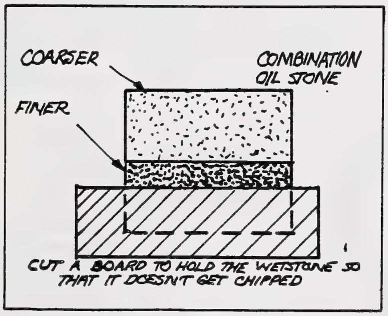
(f) Keep grinding until you have one smooth grind across the tip of the plane iron and it comes to a sharp edge. Frequently dip in the water.





2. Whetting a Plane Iron

After grinding, a plane iron will be properly shaped but will not be sharp.



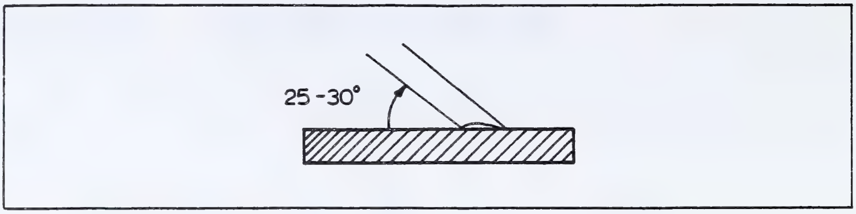
The next step in the sharpening process is whetting. Whetting is done on an oil stone. Oilstones usually have a coarse grit on one side and a fine grit on the other. If the grinding wheel is coarse you will probably have to start on the coarse side of the whet stone and then move to the fine side. If, however, the grinder is fine, you could go immediately to the fine side of the whet stone.

The procedure to follow when whetting a plane iron is listed below.

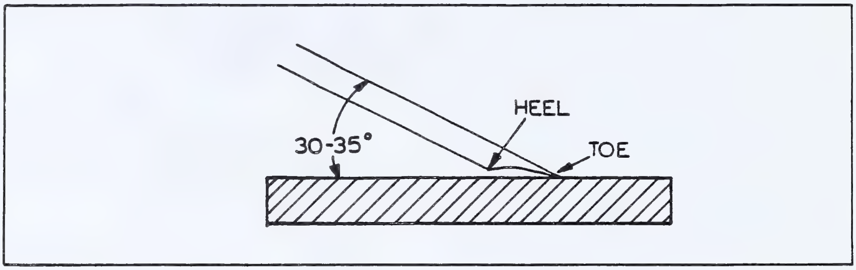
(a) Place oil on the surface of the whetstone. (NOT all stones are whetstones.) This can be any light oil or a mixture of oil and kerosene. The purpose of this oil is to float the dust and metal particles off the stone. This makes the stone cut faster.

If no oil was used for a time the stone will become clogged (glazed) and have a shiny black appearance. Adding oil and keeping a layer of oil on the stone as you are using it will eventually clean the stone and keep it clean.

(b) Rest the bevel of the plane iron flat on the oilstone.

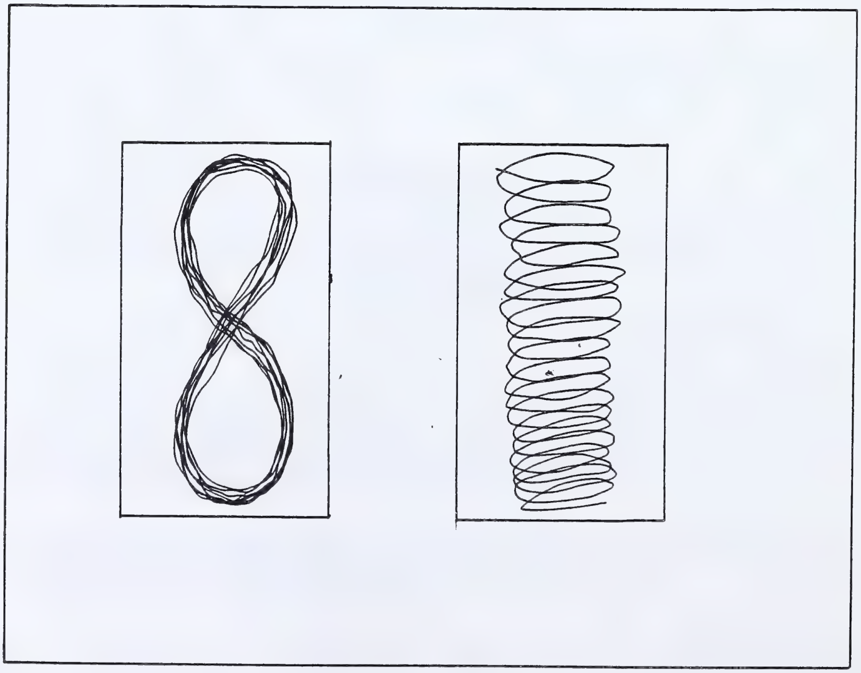


(c) Raise the plane iron 5°. This will be enough so that the tip of the bevel is whetted but not heel. This does not give you an incorrect angle. It does, however, make the plane iron easier to sharpen. You are whetting only the cutting edge and not the whole bevel.



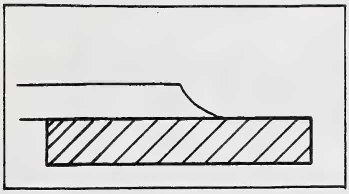
(d) Start to whet at one end of the stone and work the full length to the other end. In this way you will not get a hollow spot in the stone as a hollow spot ruins a whet stone.

Some carpenters make use of a figure 8 pattern as they cross the oilstone. Other people use an overlapping circular motion. Any system works as long as you do not whet in the same place on the stone everytime.



Do about ten figure 8 strokes or twenty circular strokes on the plane iron.

(e) Turn the plane iron over and lay it flat on the whetstone. Make sure it is flat on the stone as you do not want any slope on the back of the plane iron. Do four or five strokes. This will remove the feather edge (it is also called a wire edge or a burr).



(f) Check for sharpness. If the plane iron is as sharp as a good knife you have completed the whetting process. If it does not seem sharp yet, repeat steps (b) to (f).

3. Honing the Plane Iron

Most carpenters whet their plane irons on a fine whetstone and do not hone them. Honing does, however, produce a razor sharp edge for fine finishing of wood (especially hardwood).

Honing is done on a very fine white stone (lily stone) or on a leather strop (see chart number 11 on page 17 of Lesson 2).

The procedure for honing on a lily stone is the same as for whetting. The procedure for a leather strop is to place the bevel on the strop and draw the plane iron back. This is done so you do not cut the leather. Several strokes are taken.

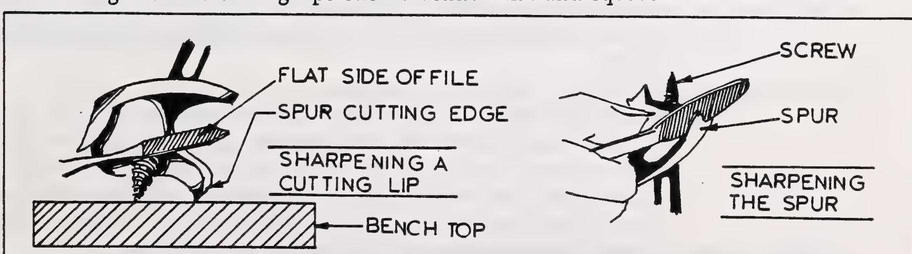
The procedure given above is for plane irons. However the same step by step procedure is used for wood chisels and spoke shaves.

SHARPENING AUGER BITS

When sharpening an auger bit a special file is used. On one end the file has cutting surfaces only on the flat sides and at the other end has cutting surfaces only on the edges.

AUGER BIT FILE

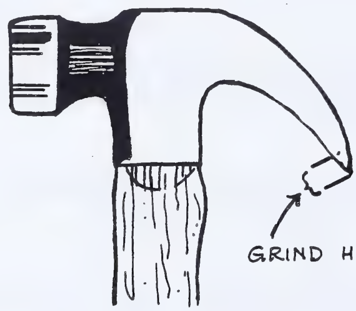
When filing auger bits, file on the inside of the spurs, never on the outside. If the outside of the tips of the spurs are filed the cutting diameter is reduced and the bit will tend to bind in the wood. File only on the upper, curved edge of the cutting tips. The bottom edges of the cutting tips should remain flat and square.



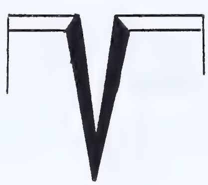
RENEWING TOOLS BY GRINDING OR FILING

Edges, sides, and ends of tools such as hammers, wrecking bars, scratch awls, scribers, and screwdriver bits become flattened, mushroomed, or worn, and must be returned to their original shape to perform their job well.

1. Hammers often get their claw ends flattened over a period of time and will no longer hook onto small nails. The end can be ground on the inside. This leaves a burr on the outside that can be removed with a flat mill file.



The slope on the inside of the claws can be reconditioned by filing on the inside of the claws with a triangular file. The burr formed on the outside can be removed with a flat mill file.



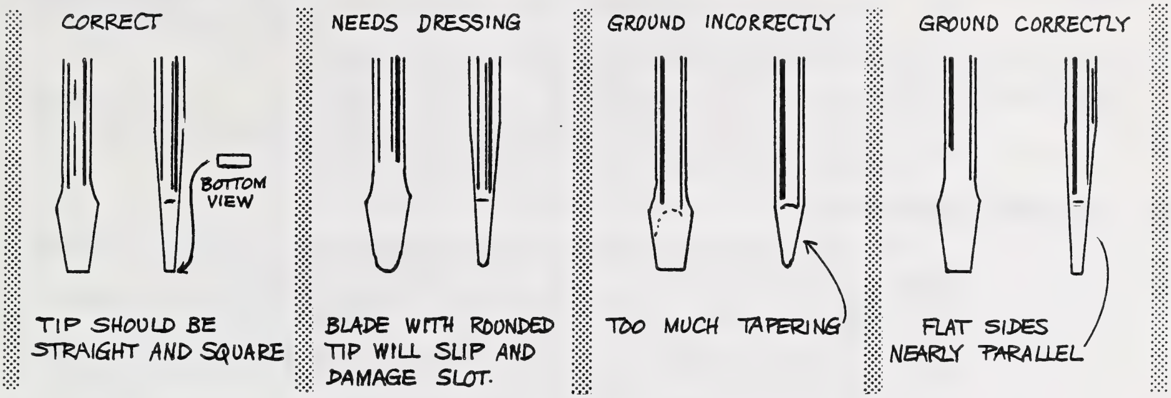
This procedure can be used when the hammer tends to break nail heads loose and won't pull the nail.

Both of these procedures are not recommended for a hammer with a lifetime guarantee as they can be replaced free of charge if they chip or wear.

2. To renew the point on a scratch awl or scriber, use a medium flat mill file (single cut) and follow the original angle. Touch-up gently - just file enough to renew the point or edge.

3. Push Drill bits can be easily touched-up on a grinder. Put a bit in the push drill, rest it on the tool rest of the grinder, and turn until you match the existing angle. Just push hard enough against the grinding wheel to produce a sharp edge. Be careful to check that the two grinds meet in the center. Twist drills are sharpened in the same manner. It is best to have someone demonstrate proper procedures here.

4. Everyone seems to abuse screwdrivers. They are used for pry bars, nail pullers, chisels, can openers, etc. and they are often used to drive the wrong sized screws. Consequently the tips of them turn out to be chipped, round, sharpened to a knife point, bent, and twisted. They can however, be renewed. Carefully grind screwdrivers on the side of a grinding wheel. Be careful not to overheat the tip as it will lose its temper and therefore lose hardness.



GENERAL MAINTENANCE

1. Adjusting Tools

One thing to keep in mind is that when manufacturers make a tool, they choose the type of adjusting device with care. If the adjustment will be hard the manufacturer will put a large lever on the tool to keep the required force necessary to adjust tool down to a level where everyone can make the adjustment. Likewise if the adjustment is very easy they will use a small device such as a thumb screw. In other words you should never have to use excess force in order to adjust the tools.

You will have to learn to recognize what excessive force is. Below are some examples of things not to do when adjusting tools.

(a) Do not use pliers on fastening devices designed for hand tightening.

(b) Do not use pry bars to adjust tools.

(c) Use reasonable force on a wrench when tightening a set screw. Do not pull as hard as you can.

(d) Hand tools should not be difficult to use. Do not apply excessive force.

(e) Recognize that most plastic and aluminum parts are brittle so do not pound on tools with these parts.

(f) Each of the hand tools has its acceptable uses. Do not try to use tools for jobs they were not intended to perform.

If you find you are doing any one of the previously listed 'do not do's', look for a reason. Do not just keep on forcing or abusing your tools. Find out why it is not working properly and repair it.

Below are listed some reasons why your tools may be hard to adjust or use.

(a) sticking because of lack of oil.

(b) improperly assembled.

(c) corroded parts - usually caused by lack of maintenance or poor storage.

(d) Wrong adjustment being tried. Make sure you know the order in which to make adjustments. In other words, read the operator's manual for an explanation on how to adjust the tools.

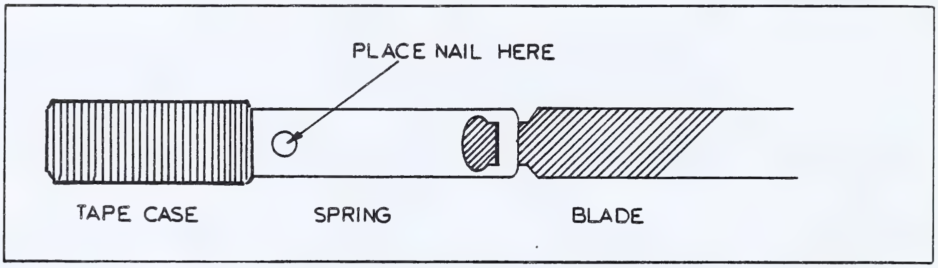
(e) Dull tools are not only hard to use, they are dangerous. They will not dig into the wood as well as sharp tools and hence can slip much easier. Remember, for example, a chisel does not have to be very sharp to cut you.

2. Choosing Correct Tools

When you have a choice of different sizes of tools it is easy to take the wrong size because it was the easiest one to find. This is a bad habit. This idea can be demonstrated using screw drivers as an example. With screwdrivers there are many sizes available. If you use one that is too small it will slip off the screw, usually chewing up the drive slot as it slips. It is also possible the screwdriver may be twisted. Use a screwdriver with the proper size tip in good condition. This will help ensure that the wood screw can easily be driven without damage to it.

3. Tool Repair

Blades for push-pull tapes can be easily replaced but be careful to put a nail through the hole in the spring where it comes out of the case.



Note which side of the spring the blade comes through and reassemble the new blade the same way.

Occasionally, especially if you have been working in wet weather, pull the blade out and run it through a lightly oiled rag and then a dry rag to remove any surplus oil which will collect dust.

Bit braces, hand drills, push drills, ratchet screwdrivers, etc. all require light oiling when they become hard to operate (oil regularly if they are in constant use). Most tools will last for many years and give little or no trouble if you check, when you first buy them, to see what kind of maintenance is required and then do regular maintenance. Some tools, such as a hammer, of course require little maintenance if used properly. However, push drills and spiral ratchet screwdrivers should be oiled two or three times per week if used quite steadily. Oil the same way as recommended for a rifle or shotgun. Put a light coat of oil and then wipe off as much as possible. Too much oil collects dust and jams tools in cold weather.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. What are the three operations involved in sharpening a plane iron?

   (a) ______________________________

   (b) ______________________________

   (c) ______________________________

2. A plane iron must be ground if it has any one of three faults listed in this lesson. What is done if it does not have any of these faults but still needs sharpening?

____

____

3. What is the correct angle to grind a plane iron at?

____

4. What will happen to a plane iron if it gets too hot while being ground?

____

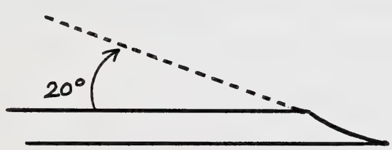
____

5. How can you tell if a plane iron has been overheated?

____

____

6. What effect will changing the angle of the bevel to the smaller angle of 20° have on the plane iron and the way it cuts the wood?



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____

____

7. The plane iron will burn on the grinder if you:

(a) ____

(b) ____

8. When whetting a plane iron you should use the whole surface, not just one place on the stone. Why?

____

____

9. The correct angle to whet a plane iron at is _______ degrees to _______ degrees.

10. The angle that a plane iron is whetted at is always _________ degress more than it is ground at.

11. A chisel that cuts only if you push on it very hard is dangerous to use. Why?

____

____

____

12. What happens (when driving screws) when a screwdriver tip has too much taper?

____

____

13. How do you know what angle to grind or file a tool if it is so badly damaged that you cannot see the original angle?

____

____

14. What is 'temper'?

____

____

____

____

15. When you have ground the plane iron to a point, you will find a slight burr on the back of the long edge. How do you remove this burr?

____

____

____

16. When whetting the iron on an oilstone, you rest the bevel of the iron flat on the oilstone, then raise the heel about 5°. Why?

____

____

EXERCISE 2

1. List three things that should be done if you try to adjust your hand plane and find that the depth adjusting nut turns very hard.

   (a) ______________________________

   (b) ______________________________

   (c) ______________________________

2. Why is oil used on a whetstone?

   ____

   ____

3. How do you renew the point on a scratch awl or scriber?

   ____

   ____

   ____

4. What could possibly happen if you chose a screw driver that is larger than it should be to drive in a screw?

   (a) ______________________________

   (b) ______________________________

5. What happens if you rock the plane iron up and down as you whet it?

   ____

   ____

   ____

6. Why do you avoid putting any bevel on the flat side of a plane iron?

   ____

   ____

   ____

7. What does honing do?

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   ____

END OF LESSON 7

LESSON RECORD FORM

1836 Building Construction 12
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Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

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FINISHES AND APPLICATORS

Finishes
Applicators
Surface preparation
Safe practices

Introduction

Three important reasons for finishing a surface are protection, decoration, and sanitation. Other reasons include improved lighting, safety, and improved working conditions.

The term protection means that the surface coating will protect the wood from one or more of the following destructive influences; wind, rain, ultraviolet light, heat, dirt, gases, and fungi. Ultraviolet light is one of the more damaging influences. If a surface is protected by a clear finish it still tends to deteriorate when exposed to sunlight. Paint has also been shown to reduce fire hazards.

Concerning its decorative value, finishes have the ability to increase the attractiveness of a building or piece of furniture. Decorating an item is always the result of finishing. This tends to increase its value. A painted, bright looking house is worth more than an unpainted, drab looking house.

As far as sanitation is concerned a surface coated with a smooth unbroken finish is much easier to keep clean than a rough unpainted surface.

FINISHES

1. Pigmented Coating (paint)

There are two basic types of paint. These are the oil base paints and the emulsion paints (more commonly referred to as latex paints).

(a) Oil based paints have until recently, been the most common and durable of the two types. They produce a coating that is completely opaque and sealed. The opaqueness insures that the wood is not exposed to ultraviolet light which tends to be destructive. The fact that the surface is sealed makes oil based paint a good choice for items such as boats or washroom walls which are exposed to severe moisture conditions. Oil based paint is, however, not the best choice to use on the outside walls when they are not sealed with vapour barrier since the moisture migrating through the walls will cause blistering of the painted surface.

The basic components of an oil based paint are pigment, vehicle, thinner, and drier.

(i) Pigment is the component that gives paint colour and the ability to hide. In white paints white lead, zinc oxide, titanium white, and lithopane are widely used as pigments.

(ii) Vehicle is the fluid (non-volatile) in which the body is suspended. It should constitute 40% of the paints volume. The vehicle is made up mostly of drying oils such as linseed oil, dehydrated castor oil, tung oil, or fish oil. Some thinners and driers are also included.

(iii) Thinners are volatile solvents added to make paint flow better and which evaporate when the paint is applied to a surface. Turpentine is the most common thinner used.

(iv) Driers are added to speed up the oxidation (drying) and hardening of the paint.

(b) Emulsion paints (oil resin emulsion and latex emulsion paint)

An emulsion is defined as a suspension of fine particles of a liquid dispersed in another liquid. Milk is nature's emulsion in which butter fat is suspended in milk (mainly water).

With emulsion paints water is used as the thinner. The vehicle in oil resin emulsion paints is oil as in oil based paints. The vehicle in latex emulsion paints, however, is latex, a rubbery material which acts as a pigment, binder, and film forming material for the paint.

After the paints are applied, water evaporates from the paint and this leaves a film of resin on the wood which cannot be washed off and is almost as durable as oil based paint.

Latex is used for indoor and outdoor painting. One limiting factor is that the latex paints cannot be applied to a glossy surface as they tend to crawl.

Latex paints cannot be stored where it will freeze as the thinner is water. Freezing breaks down the emulsion and the paint separates and cannot be remixed.

Once these paints have dried they are quite washable and water resistant. However, before they have dried they can be washed off with water. Hence paint brushes and spills can be cleaned up by using water.

There are many advantages to latex emulsion paints.

(i) Latex paint is suitable for plaster and gyproc as it has practically no penetration into the surface upon which it is applied.

(ii) Latex paint has less of a tendency to turn yellow than oil based paints.

(iii) Latex paints use a very inexpensive thinner (water). This makes brush cleaning easy and inexpensive.

(iv) Exterior latex paints do not blister as they do not seal the surface like oil based paints and, hence, moisture can escape through the paint film. Oil based paints tend to seal the surface and therefore, moisture migration from inside the wall the outside tends to cause blistering of the paint.

(v) Latex paints do not present a fire or explosion hazard.

(vi) They dry quickly -- within 1 to 2 hours whereas oil based paints take 8 to 12 hours to dry.

2. Resinous Coatings

Resinous coatings are used where it is desirable to see the color and texture of the wood.

Resinous coatings contain a resin (body), a vehicle, a thinner and sometimes a pigment. The resin is the solid portion and gives the varnish (or plastic) film its luster and hardness. The vehicle is oil which makes a tough durable elastic finish (when it dries). The oils could be linseed oil, soybean oil, safflower oil, tung oil, sunflower oil, or others. The thinner is mineral spirits or turpentine. Pigments are added to varnish to make enamel.

There are several classifications of varnish:

(a) Natual resin varnishes

The body is made up from natural resins. These resins are made from the sap of living trees or from fossil deposits of trees. It is dissolved in one of the drying oils. A thinner (turpentine) is also used. There are three main types of natural resin varnishes.

(i) Spar and marine varnishes have more oil and less resin. They take longer to dry but are tougher and more water resistant.

(ii) Floor varnishes have slightly less oil and more resin. They dry faster and have a harder, but not as waterproof film.

(iii) Rubbing and polishing varnishes have less oil and more resin. These dry hard and brittle but with high gloss. They will not resist rough usage.

(b) Synthetic resin varnishes (may also be called plastic finishes).

The resin for synthetic varnish is man-made. This resin is dissolved in a vehicle of drying oils. Plastic resins include such substances as phenolic resin, alkyd resin, amino resin, and polyurethane resin. These synthetic plastic finishes are taking over from the natural varnishes since they produce a tougher finish that costs less.

(c) Enamels

Enamels are made by adding pigment to varnish. Enamels work best with an undercoat because they do not have the covering power of paints (they lack the opaque body material of paint). Enamels tend to be brightly colored, for example, implement enamel.

Baking enamels (made with synthetic plastic resins) are used on many household appliances, aluminum siding, shingles, and other exterior and interior metal trim.

(d) Shellac

Shellac contains a resin of animal origin (the lac beetle). This resin is dissolved in alcohol. There are different cuts (grams of resin per litre of alcohol). It is usually purchased as 480 g/L cut. Usually one part of shellac is diluted with 1 part alcohol resulting in a 240 g/L cut.

Shellac dries quickly and produces a tough elastic film on wood, leather, glass, cork, and metal. It should not be used on work exposed to outside conditions as water containing alkali causes it soften and whiten. Strong sunlight causes it to discolour.

Shellac is used as a sealer for wood. It will seal the surface of closed-grained or non-porous woods. Shellac will also seal resinous knots and streaks so they will not leach into paint or varnish. It can also be used as a finish itself (i.e. french polish) involving several coats of shellac and hand rubbing.

Shellac is normally orange colour and this type can be used under other colored finishes. However, when a clear finish is required, white shellac should be used. White shellac is made by bleaching orange shellac.

(e) Lacquers

Lacquer is a relatively new product for clear finishing work. Modern lacquer is made from synthetic materials, usually nitro-cellulose. It is the toughest of the thermoplastic resins. Lacquers dry through the evaporation of the thinners. Since the thinners are very volatile some lacquers will dry in as little as 15 minutes.

Lacquers have the following advantages:

(i) they can be applied without expensive baking equipment.

(ii) it is possible to touch up marred spots easily and perfectly.

(iii) it is highly resistant to gasoline, oils and greases, soap, weak alcohol, and temperature changes.

(iv) it is stable in color while drying.

(v) it is durable on metel.

Lacquers do have some disadvantages. These are:

(i) it is difficult to apply with a brush and should be sprayed on.

(ii) it requires a sealing coat over oiled, varnished, or enameled surfaces.

(iii) it has poor exterior durability on wood because of humidity variations.

Some varnishes have flatteners added. The purpose of the flattener is to dull the natually shiny finish of varnish. Flat varnish will have a flattener added but high gloss varnishes will not. When flatteners are added to varnish, it will have to be stirred well before using since flatteners tend to settle.

3. Stains

Stains are of two types:

(a) The first type are stains which are used to give wood color (for example, darker brown, more reddish, etc.) without obscuring the grain. These do not generally provide a protective coating although some manufacturers are marketing stain/finish products. There are three varieties of tinting type stains.

(i) Water stains are easy to apply by brush, dipping, spray, or sponge and are non-fading and non-bleeding (bleeding means to diffuse into or show through a covering layer). They give deep, even penetration but have a tendency to raise the grain of wood which roughens the surface. Careful sanding is then necessary. They air-dry in about 12 h.

(ii) Spirit stains produce the brightest and strongest colors but are the most susceptible to fading and tend to bleed and raise the grain. They are often used for re-finishing and repair because of their high penetration quality. Allow 2 h drying time. They are brushed on.

(iii) Penetrating oil stains are easy to apply, but the surface must be wiped after application to remove excess stain and give an even finish. They have no tendency to raise the grain but are not as light-fast as water stains and tend to bleed into finish coats. Allow 24 h drying time.

(b) The second type are stains which are used as protective coating for exterior woodwork. These stains are of two varieties.

(i) One type is opaque and is produced by using an oil vehicle which is heavily pigmented. A fungicide is also added to prevent the growth of fungi on the finished surface. This produces a matt finish that will not crack, blister or peel. The finished surface looks similar to paint in appearance but it is easier to apply, especially on rough surfaces. These stains weather best when used on vertically installed siding.

(ii) The other type of stain is the semi-transparent stain. These are lightly pigmented, oil based stains. They serve the same purposes as the opaque stains. However, they tend to leave the natural color of the wood so it shows more.

4. Oils

(a) Linseed oil is prepared from linseed which is the seed of the common flax plant. It is prepared in several grades, including raw, refined, boiled, and blown. Refined (often commonly called raw) and 'boiled' are the two grades stocked by hardwares, paint stores, and lumber yards. Refined linseed oil is raw linseed oil with the solid fats, fragments of seeds, etc. removed. It is the slowest drying of all the grades. Boiled linseed oil dries in less time than either raw or refined oil and becomes thicker, denser, and darker. The term 'boiled' is inaccurate since linseed oil is not boiled. Driers, such as manganese dioxide, are added while the oil is hot. Some fine modern funiture is finished by applying several coats of boiled linseed oil. This gives a mellow stain appearance. The blown grade dries to a hard film as a result of having air blown through the oil while it is heated to about 125°C It is used in enamels and interior paints.

(b) 'Swedish' and 'Danish' oil finishes are composed mainly of linseed oil and also give a mellow satin appearance to wood. To apply these finishes brush on a coat of either, and sand in the oil with a circular motion, using about a #280 or #320 wet or dry sandpaper. Make sure that there is a film of oil, on the wood, especially while sanding across the grain, otherwise the wood surface may be scratched. Let dry overnight and work in another coat of oil using a finer grade of wet or dry sandpaper (e.g. #400). Repeat the next day using #600 sandpaper. For most finishes the three sandings are enough but if a very smooth finish is desired, repeat coats using #600 each time.

Make sure excess oil is wiped off after each sanding. If it is not you will have a thick, gummy film on the wood instead of a satin-like finish.

Danish oil is the darker of the two so if a natural color finish is desired use Swedish oil. Both are available in paint and hardware stores. To renew the finish at a later date brush on another coat of oil and re-sand with #600 sandpaper. Wipe the excess off with a cloth.

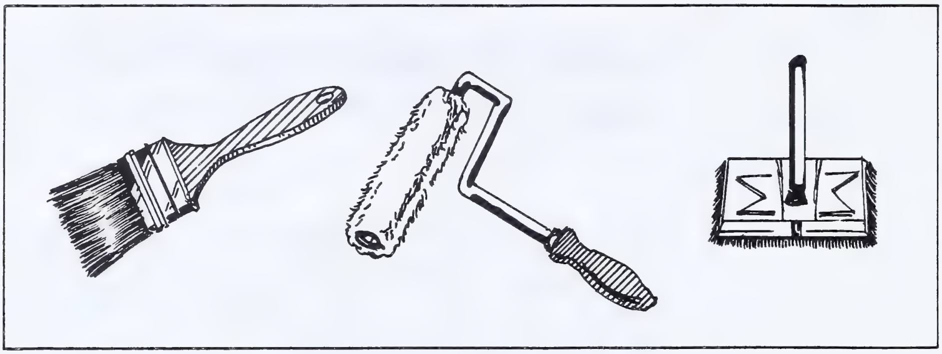
5. Preservatives

Preservatives are meant to soak right into wood fibers and cells, filling them with rot-resistant chemicals. They should be used on all surfaces exposed to earth and dampness (fence posts, piles, beams or plates at ground level, etc.) to reduce rotting.

The best method of treating wood for long-term durability is using pressure. Creosote is commonly used, along with pressure tanks for this purpose. Creosoted piles, poles, etc. are usually expected to last about 50 years (some have lasted past 70 years) depending on the amount of pressure used.

APPLICATORS

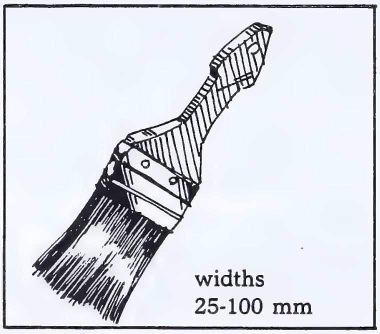
Applicators until recently have changed little. Brushes, though crude at first, have been with us for centuries. The history of brushes for applying paint goes back at least as far as Paleolithic man and, until about 1945, were the main tools for applying liquid finishes. About that time paint rollers were marketed. More recently, pads, rollers, and cornering rollers of styrofoam have been produced.



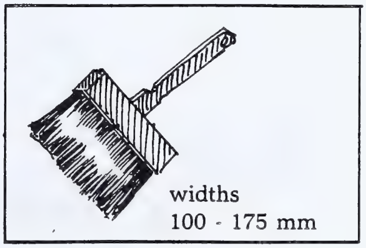
1. Brushes

Brushes are available in a wide variety of shapes and sizes for specialized uses. The bristles are either of animal hair or nylon vulcanized in rubber plugs.

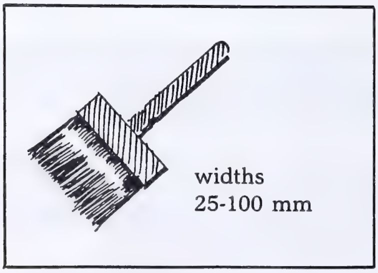
Beak Hair. Finest furniture finishing free flowing. Black Polypropylene. Coach style handle



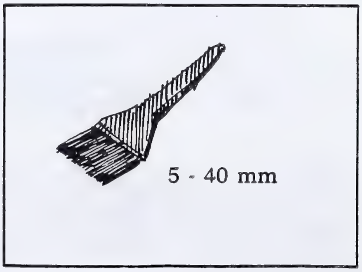
Shingle Stain Brushes. These brushes are made to be used for light staining creosoting and white-washing jobs. The bristles are a fibre and hair mixture. Clear lacquered handles.



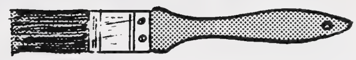
Flat Glue Brush. Pure Grey bristle brush used for heavy working with glue. Clear lacquered flat handles.



Angular style sash brush -- designed for painted into a corner or other hard to reach area.



Oxhair. Finest quality for expert colouring and varnishing of smaller projects or in hard to reach places. Plain Varnished Handles.

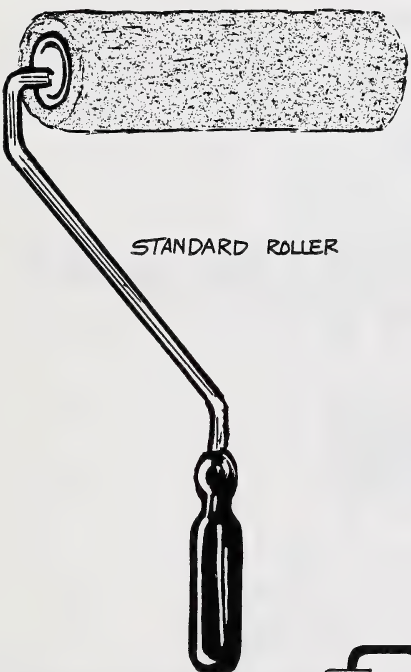


widths
5-25 mm

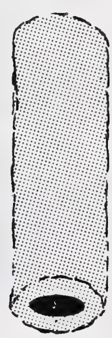
2. Rollers

Generally rollers are available in three styles:

(a) The standard roller which is about 23 cm long. This roller has several different pile heights available. (The pile is the fiber attached to the outside of the roller in order to hold and smooth out the paint). The pile can be wool, nylon, or mohair (angora goat hair). Remember short pile is used on smooth surfaces or with latex paint and longer pile is used on rough surfaces or with oil based paint. Roller frames have a threaded socket in the handle for extensions so that the top half of walls and also ceilings can be reached from the floor.

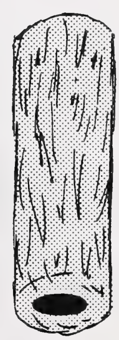


STANDARD ROLLER

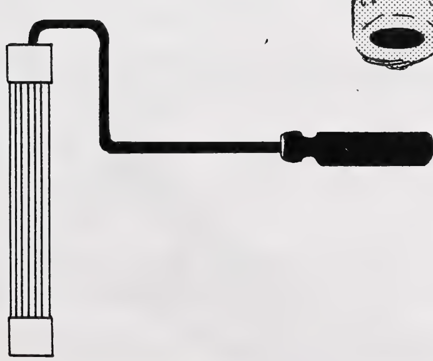


SHORT PILE

MEDIUM PILE

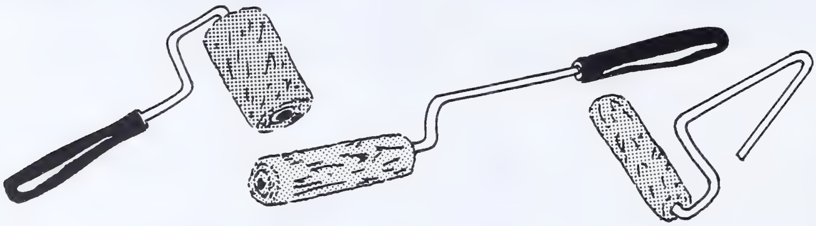


LONG PILE

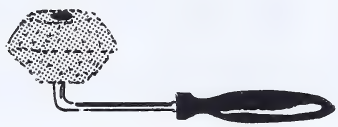


ROLLER FRAME

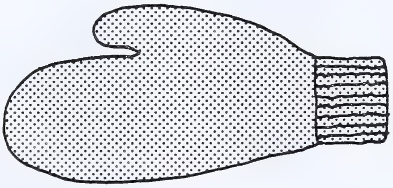
(b) Shelf rollers are about 75 mm long rollers with a pile of Mohair or nylon. They are used to paint in tight quarters such as the inside of cupboards.



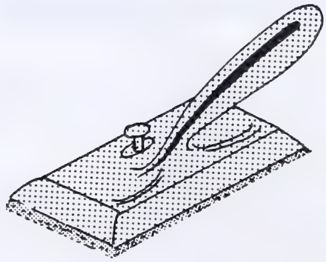
(c) Corner Painter. The foam corner painter speeds up cut-in work in corners and around moldings.



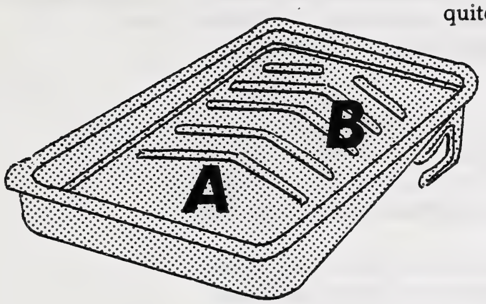
(d) Painter's Mitt. The painter's mitt is recommended for painting rails, pipes, and other contoured, irregular, hard to reach surfaces. It contains quality shearling which will apply all types of paint smoothly and quickly.



(e) Pads. Pads have nylon fibers embedded in foam pads. They are relatively easy to clean and replace in the holders.



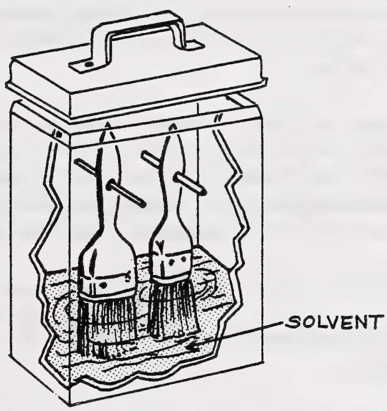
3. Roller Pans



Pans, such as shown at left, are specially designed for use with rollers. The paint is poured into (A) where the roller is dipped in the paint. Excess oil is rolled off lightly at (B) before the roller is used on the wall, etc. This pan is also quite handy for use with a brush.

4. Cleaning and Storing Paint Brushes

(a) Rinse the brushes out well in the appropriate thinner. If brush storage is to be temporary (you will use them again in a day or two) they may be hung in a can of the appropriate thinner but should be suspended from touching the bottom of the container. If this is not done the bristles remain full of paint and tend to be bent to one side. This ruins the paint brush for quality painting. A container as shown at the left is excellent but a large-size juice can also works well.



(b) If brushes will be stored for a long period of time, follow step (a) by washing the brush out in warm, soapy water (hot water damages the bristles). Most laundry soaps work well but there are special brush cleaning soaps available. An up-down motion in the soapy water forces it up in the bristles.

(c) Rinse the brush out in clear, warm water. Change the water about three times to remove all traces of soap. As in (a) and (b) use an up and down motion.

(d) Wrap the brush carefully in a piece of newspaper or paper towel. Wrap the paper around the brush carefully so that the bristles form the original shape. Use an elastic band to hold the paper or lie it flat in a cool, dry place.

(e) If some of the paint is too dry to remove with a solvent you may have to use a steel comb or wire brush to work it out of the bristles.

Do not leave wood-handled tools, including paint brushes, soaking in water. They will split.

5. Cleaning Rollers, Mitts and Pads

Rollers, mitts, and pads are cleaned in the same sequence as brushes. This sequence is:

(a) Rinse in the proper solvent.
(b) Squeeze out solvent and wash in warm, soapy water.
(c) Squeeze out soap and rinse in clear, warm water - hold under a tap.
(d) Squeeze out excess water and hang to dry.

6. Appropriate Solvents

Below is a list of solvents for cleaning brushes and rollers.

Turpentine - oil-based paint, enamel, and varnish
Water - latex and alkyd paints
Lacquer - lacquer thinner
Shellac - alcohol
Other - refer to manufacturers directions

Always clean all tools that have been used for painting or have had paint splattered or spilled on them. Pick up all rags, especially those that have been used for wiping oil stains and other volatile liquids, and place in fire proof containers (rags soaked in volatile substances can produce their own heat and burst into flame by spontaneous combustion). If you always clean up your mess immediately, tools are easy to clean and you will be much more appreciated either around home or job-site, than if you continually leave a mess behind you.

SURFACE PREPARATION

The preparation needed for finishing a surface varies considerably depending on the type of product being done and the type of finish used. For this reason not all variables can be considered. This section of the lesson will deal primarily with specific projects.

1. Furniture Finishing

The following steps are recommended for getting a solid wood surface smooth enough to stain and varnish.

(a) Plane the surface. Place the plane iron cap so it extends to within 0.75 mm of the end of the plane iron for best results.

(b) Scrape the surface with a cabinet scraper. Do not scrape end grain.

(c) Sand the surface. Use 80 to 120 grit for first sanding and 150 to 220 grit for the final sanding. SAND WITH THE GRAIN ONLY. If you sand across the grain, the abrasive cuts the wood fibers and these are brought out by the stain as ugly, undesirable lines. Sand the end grain only in one direction to comb the end grain fibers down for better finishing.

(d) Remove all glue spots. Glue spilled on the surface seals the wood so stains will not soak in. This leaves the glue spot a different color. Also glue tends to make varnish look more white. When glue is dropped on to a surface which is to be finished it is best not to rub it off with your finger as you tend to smear the glue over a wider area. One way to remove the glue is to let the spot dry and then carefully remove it later with a wood chisel.

(e) With 180 to 220 grit sand paper soften all square or knife edges. However, do not round them.

(f) Thoroughly dust the surface. A lint-free cloth slightly dampened with turpentine should be used for the final dusting.

2. Suggestions for Exterior House Painting

The following items are suggestions to look at when deciding which paint is best for your job.

(a) When finishing new wood make sure the surface is clean and dry.

(b) Latex paint breathes and hence moisture problems in walls will not cause it to blister as the oil base paint does.

(c) Latex paint will not stick well to glossy surfaces so sanding or scraping may be necessary before latex paints can be used. Oil based paints are better for semi-gloss type surfaces but will not stick well to high gloss surfaces.

(d) Flat latex paints do not have as hard of a surface as oil based paints and hence wear off easier when rubbed. Semi-glossed latex is better at resisting being rubbed off.

(e) Stains in general work better on vertical siding than on horizontal siding.

SAFETY

Safe practices are essential when finishing. Some finishing materials are very volatile and under certain conditions burn with such rapidity that an explosion results.

Many solvents are injurious to health if contacted while the vapours of others are poisonous and can cause death.

One item a painter should always do is to read the paint can and thinner can directions carefully.

1. Safety Suggestions

(a) Place all oily rags in a closed, metal container. Most fires in a finishing area are caused by spontaneous combustion.

(b) Avoid open flames or sparks. The vapours of some volatile solvents can drift and be ignited by a flame several metres away. Once source of flame most people do not tend to remember is their furnace, or hot water heater pilot light.

(c) Work only in a well ventilated area or use a safer finishing material (latex paint releases very few fumes).

SUMMARY

For proper wood finishing follow the proper steps for each type of finish. Some finishes require a great deal of care and preparation while others, such as wood preservatives, require little or none at all.

Remember that several thin coats are superior to one or two thick coats. The first one or two coats, especially, should be thin as they soak in more and give better adhesion than a thick coat that floats on the surface. Sand between coats.

If in doubt about a finish, ALWAYS experiment on a scrap piece of wood first.

A glossy surface (either paint or varnish) is more durable and washable but shows blemishes more easily as it reflects light unevenly around the blemish. Use a semi-gloss (satiny or dull) where appearance is more important than durability.

People today prefer a dull matt finish rather than a high gloss on most furniture. We like to see through the finish to the natural grain of wood, not see the finish itself. Thick, high gloss finish is more usual on cheap furniture than good furniture.

Answer the following questions and send them in for correction.

EXERCISE 1

1. List four reasons why projects are finished.

   (a)____________________ (c)____________________

   (b)____________________ (d)____________________

2. Why do exterior oil-based paints tend to blister?

   ____

   ____

3. When blistering is a problem what can be done to correct the problem?

   ____

   ____

   ____

4. What height of pile should a roller have if you use it for applying latex paint to a rough surface?

   ____

5. Why are thinners added to paints?

   ____

6. Give four reasons why latex paint is preferred for interior house painting.

   (a) ____

   (b) ____

   (c) ____

   (d) ____

7. Give two reasons why synthetic plastic finishes are becoming more popular than the natural resin varnishes.

   (a) ______________________________

   (b) ______________________________

8. Why can latex paint not be allowed to freeze?

   ____

   ____

9. Why would you sometimes prefer to use varnish instead of paint?

   ____

   ____

   ____

10. Enamels are made by ______________________________

    ____

    ______________________________.

11. Why is boiled linseed oil rather than raw linseed oil used in paints?

    ____

    ____

12. How are preservatives meant to work?

    ____

    ____

    ____

13. Why is shellac not used for exterior applications?

    ____

    ____

    ____

14. Why is lacquer not very commonly used by the home handy person for cabinet work?

    ____

    ____

15. Describe the two categories of stains. Discuss the similarities and differences.

16. What is the main ingredient in 'Swedish' oil finish?

17. In one of the previous lessons on tool maintenance, which finish was suggested for tool handles?

18. Why are brushes still used for painting when rollers are much faster?

19. A new style of paint brush has been introduced lately which has a foam pad end instead of bristles. Can you think of an advantage of this new brush. What is it?

20. Explain the procedure you should use to clean a brush used to paint a bench with oil-based exterior house paint.

21. What happens to a project if you sand across the grain of the wood when preparing it for varnishing?

22. Why is it best to thoroughly dust a surface before varnish is applied?

23. What are some possible reasons why the life expectancy of an exterior varnished finish is two years when the life expectancy of paint is four or five years?

24. Why is it extremely dangerous to work with volatile solvents in your basement?

END OF LESSON 8

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

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ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

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SAFETY

Causes of accidents
Accident prevention

INTRODUCTION

In general an accident is an unplanned and unexpected event which interferes with the activity a person is engaged in. An accident can happen to the worker himself or it may lead to the injury of other workers.

The result of an accident to an individual can range from minor irritation to major injury and disaster. To the equipment being used an accident can cause no damage or total destruction.

When an accident occurs one can never be sure of the outcome. This is the reason why a person has to strive to prevent accidents.

Safety as discussed in this lesson will be aimed at the causes of accidents and ways to eliminate these causes. The information covered will apply to the work situation, but many of the pointers will be very useful in avoiding accidents at home and at play as well.

CAUSES OF ACCIDENTS

Keep in mind that accidents do not just happen. They are caused. For example, a person can easily cause an accident to happen by holding a board with his left hand and chiselling toward his hand with a wood chisel. The question here is not whether an accident will happen but when the accident will occur since it is guranteed that the chisel will eventually slip.

The worker would not be truthful in saying, 'Look, an accident happened to me'. He should say, 'Look, I just caused an accident to happen to me'.

ACCIDENTS ARE CAUSED. HELP REMOVE CAUSES

Below are some of the more common causes of accidents.

1. Unsafe Acts

An unsafe act is any departure from an accepted, normal or correct procedure or practice which may cause an accident or injury.

Below is a list of many acts which are considered unsafe.

(a) Activities such as: operating equipment unexpectedly without warning people in the vicinity, operating equipment before checking out its condition with a supervisor and receiving permission, and operating equipment before securing accessories, all constitute unsafe acts. Below are some specific examples.

(i) Starting equipment without authority or without letting other workers know your intention leaves these workers unaware of what is happening and this increases the chance of an accident occurring. Sudden unexpected stopping of equipment can also cause an accident.

(ii) Failure to secure is another cause of accidents. Failing to secure can mean failure to lock brakes or block vehicles against unexpected motion. This is especially important when working under a vehicle. Failure to secure can

also apply to locking a switch in the off position so another worker will not accidentally turn the switch on and cause an accident. An electrician can easily be electrocuted because another worker did not notice him working on a piece of equipment before he turned on the electrical breaker. The electrician should label the breaker box with a warning sign indicating the equipment is being serviced and then lock the breaker in the off position.

(iii) Failure to shut off equipment when not in use can lead to people accidentally touching moving equipment.

(b) Another unsafe act is operating equipment at unsafe speeds or working at unsafe speeds. Examples are listed below.

(i) Running on a job site is never considered safe. There are endless obstacles to run into especially if one were to slip and fall.

(ii) Walking backwards is a very unsafe act.

(iii) Working too fast or too slow and thus endangering others is unsafe.

(c) Making safety devices inoperative is extremely hazardous. Remember they are there for a reason. Why are they installed on machines? -- For the protection of the worker so he will not get caught in the machine or cut by it or hit by flying parts, etc. Below is a list of things to observe.

(i) Do not remove or disconnect safety devices.

(ii) Do not block, plug, or tie safety devices so they do not function.

(iii) Do not replace safety devices with those of improper capacity. For example, do not use higher amperage electrical fuses than those recommended.

(d) Another extremely hazardous act involves using equipment which is unsafe. Some examples and the hazards they present are listed below.

(i) Using defective equipment such as cold chisels with mushroomed heads. Metal chips can break off these heads and injure or blind the operator or an observer.

(ii) Gripping objects insecurely or incorrectly. A hammer, for example, can very easily slip out of your hand if you do not grip it firmly. A flying hammer is extremely dangerous to other workers.

(e) Unsafe procedures involving loading, piling, or mixing supplies can be an extremely dangerous act. Examples are listed below.

(i) Overloading a machine (a hoist for example) may cause a lift cable to break and the load to fall.

(ii) Incorrect mixing can cause serious explosions, fires, and burns. For example, pouring water into acid is wrong. If done it can cause serious heat and acid burns as the solution boils violently when the water is added.

(f) A worker must always be observant about his location or posture.

(i) A worker who moves under a suspended load is performing an unsafe act.

(ii) Also the worker is performing an extremely unsafe act if he enters a tank or vessel without checking to ensure there is adequate oxygen and no poisonous gases inside.

(iii) Lifting with a bent back is an unsafe act which could lead to serious back injury.

(g) Working on or around moving or dangerous equipment can lead to many unsafe acts. Some unsafe acts are:

(i) Getting on or off moving equipment (vehicles, conveyors, elevators).

(ii) Cleaning, oiling, and adjusting moving machinery. Always stop a machine before adjusting and servicing.

(iii) Working on electrical equipment without disconnecting the power source.

(iv) Welding or cutting on dangerous materials. (Many gasoline drums have exploded when a person has tried to remove the top with a cutting torch. Fumes will remain in these drums for years.)

(h) Distracting, teasing, abusing, or startling, etc. are all unsafe acts.

(i) Any distraction can lead to the workers attention being diverted from his job and as a result he could get caught in a machine or cut. Startling a worker could lead to the same result.

(ii) Throwing material distracts or injures workers and hence is an unsafe act.

(iii) Practical joking is also an unsafe act.

(i) Failure to use safe attire is also considered an unsafe act. Examples of unsafe acts related to this are:

(i) Failure to wear eye protection, gloves, masks, aprons, or proper shoes.

(ii) Wearing long sleeves, loose clothing, ties, etc.

(iii) Failure to report any safety apparel that is defective.

Keep in mind that what might be considered a safe act in one type of work may not be safe for other types of work. A good example of this concerns the use of gloves. Gloves are a necessity for a person working with hot metals but gloves may cause serious injury to someone working around moving parts as the gloves may get caught and pull the operator into the machine.

2. Unsafe Conditions

An unsafe condition is any hazardous physical condition which if left uncorrected may lead to an accident.

Below is a list of the types of conditions which are considered unsafe.

(a) Improperly guarded, incorrectly guarded, or unguarded machines are considered unsafe as they expose the worker to moving parts or hazards from flying materials.

(b) Defective equipment would also provide unsafe working conditions. Machines which are aged, worn, or have cracked parts are unsafe. Floors which are slippery are also considered unsafe.

(c) Hazardous procedures or arrangements present the worker with unsafe conditions. Some of these unsafe conditions are listed below.

- (i) Improperly stored or piled materials and incorrectly stored tools.
- (ii) Congested work areas or inadequate aisle space.
- (iii) Oil, water, grease, or paints on a working surface.

(d) Improper lighting is another unsafe working condition. Insufficient or no light makes it harder to recognize hazardous conditions. Glare could result in the same thing. Excess light such as from welding could lead to eye damage and hence this presents and unsafe working condition.

(e) Improper ventilation in the work area which results in excess dust, fumes, or temperature can be hazardous to the workers health. Some fumes can in fact be fatal if not removed immediately.

(f) Unsafely designed or constructed equipment can mean unsafe working conditions. Scaffolding which is improperly constructed can be fatal to a worker on them if the structure collapses.

The National Safety Council released the following statement concerning causes of accidents:

Unsafe acts cause	88% of all accidents
Unsafe conditions cause	10% of all accidents
Acts of God Cause	2% of all accidents

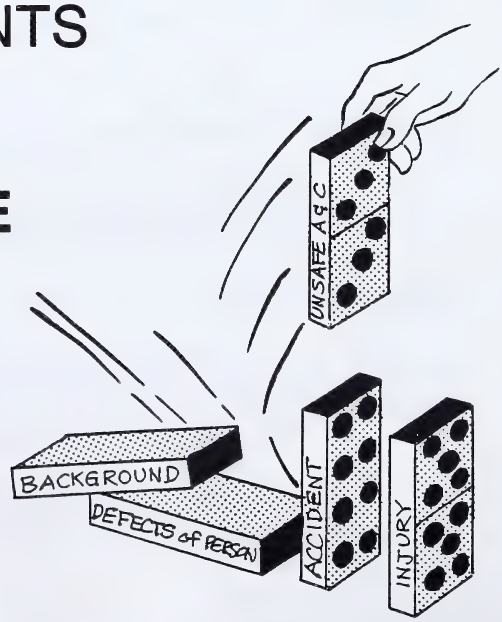
HELP PREVENT ACCIDENTS

ELIMINATE THE

UNSAFE ACTS

AND

CONDITIONS



ACCIDENT PREVENTION

Accidents can be prevented by removing the unsafe acts and conditions. This, however, is easier said than done. Before these unsafe acts and conditions can be removed, they must be recognized. The greater a persons ability to recognize a dangerous act is, less accident prone he tends to be.

1. Know Your Tools

The more that a person knows and understands about a tool, the less likely he will be to have an accident with that tool. Below are some suggestions for recognizing where accidents may occur.

(a) Cutting tools are designed to cut away materials. If a worker is positioned so he is ahead of a cutting tool, any slip will cause an accident. A good example of this is a wood chisel. Any slip of a chisel when the worker has a hand in front of it could cause a cut. However, a less recognized but more dangerous act occurs while pushing a board into a table saw. If the person positions a hand in front of the blade and pushes the board towards the blade, any slip could result in the loss of his fingers or entire hand.

Knowledge of safety should be transferred from one situation to another. The previous examples point this out quite well.

(b) All tools and machines have correct operating procedures. Do not use the tools or machines until you are familiar with these procedures. It is possible to gain this knowledge from books on machine operation or from a good demonstration by a knowledgeable person. Do not attempt to operate a machine until you know how to do the procedures correctly and know why they are done that way.

(c) Tools and machines have limitations. They will only do the jobs they were designed for. Carefully read the instruction booklet to determine which jobs can be done. Also check for suggestions on operating procedures and warnings.

(d) Check for bulletins published by the equipment manufacturer concerning updating older equipment. Also check for hazards which may have been discovered in newer equipment.

2. Know Yourself

Every person has limitations, both physical and mental. For example, do not attempt to do jobs for which you are not strong enough to handle. If material is removed from a shelf but cannot be held because it is too heavy, an accident could easily result. Close calls should be a warning that proper procedures are not being followed.

ACCIDENT PREVENTION MEASURES

Below is a list of common accident causes and methods of prevention.

1. Wear Safety Goggles

Although most parts of our anatomy are designed to be of some use to us, possibly none is more important and none more vulnerable than the eyes. Be sensible. If there is any remote possibility that your eyes may be in danger, wear hard safety goggles. If you cut your hands it may be painful but they'll heal. Cut or burn your eyes badly and you're blind for life. Below is a list of some of the work situations which require eye protection.

(i) Doing hand work with a hammer and cold chisel (either yourself or someone near you),

(ii) Working near a welder,

(iii) Using a grinder (portable or stationary),

(iv) Using a skilsaw, table saw, radial saw, sander, etc.,

(v) Working under a machine, floor, or roof, where dust or dirt may fall into your eyes,

(vi) Riding a motorbike or skidoo,

(vii) Anywhere that an object may be thrown or may fall into your eyes.

(viii) When using fuel to burn scrap piles.

2. Keep Hands Away from Cutting Edges

As cutting edges on tools were designed to quickly remove material, they can easily cut the operator. It is best to show proper respect for these cutting edges. Below is a list of do's and don'ts concerning cutting edges.

(i) When paring with a wood chisel keep both hands on the chisel. NEVER put your hand out in front of the work where it may be gouged by the chisel if it slips.

(ii) Never hurry or rush around power machines and always use push sticks and push blocks (if a mistake does occur at least it's only the push block that gets chopped to ribbons).

(iii) When using portable power tools (e.g. - skilsaw) use saw horses so that you are not tempted to put your hand under a board to hold it.

(iv) Never reach in front of moving machinery (table saw, car, combine, radial saw, grinder) to remove or check something. Stop the machine and then check.

3. Maintain Tools

As mentioned in other lessons, if you maintain tools you can do better work and will be much safer. There is little excuse for a nut, bolt, or blade to fly off a machine suddenly. It had not likely been checked for some time previously. When a tool is dull, you have to push or hit much harder than normal. A carpenter fell off a roof one day because the skilsaw he was using had little set and was quite dull. He had to push so hard to cut that, when the saw finally cut through the board, the momentum carried him off the edge.

4. When Necessary Wear a Hard Hat

There is absolutely no need to wear a hard hat if you're working by yourself nailing shingles on a roof, or subfloor down to floor joints - and nobody is insisting on that. Even if one or two other people are working with you on those two jobs it would be stretching a point quite far to insist on you wearing a hard hat. But, it is just as foolish NOT to wear a hard hat when there are a number of people working around you, or if you're working on a floor where people are working above you, or working with tools such as powder-actuated tools where a hardened nail may be deflected by a stone or piece of steel.

5. When Necessary Wear a Dust Mask

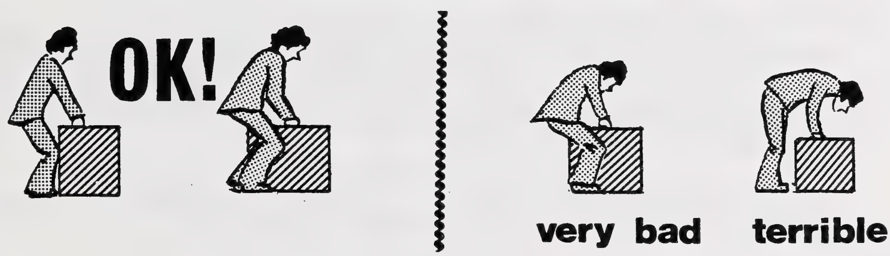
If you're helping to sweep up and clean out a series of apartments, which were drywalled, there will be a great deal of fine dust floating in the air. If you breathe this dust for any length of time you may get a pain across the upper back and cough up dust for two or three days. Any safety supplier will have a fairly cheap mask (which you should use in a situation like this). Put one in your home, car, or tool box.

6. Be Sure of Ladders and Scaffolds

It is unsafe and difficult for carpenters to work on the walls and roof of a building unless they can reach the work comfortably and ascend and descend safely. Too often ladders and scaffolds are slapped together quickly, with little or no planning, and then poorly braced. When in doubt about the stability and strength of scaffolds or ladders, stay off them! If someone insists that work be done from poor scaffolds or ladders, let him do the job, you pick up the pieces when he falls. Carpenters have been expected to work on a short ladder with the bottom end on a large box which, in turn, rested on a shaky scaffold. In that sort of situation it is not a question of whether there will be an accident, but when the accident will happen.

7. Lift With a Flat Back

This is a commonly ignored rule with the result that there are a large number of people with 'back trouble'. Chiropractors and weight lifters will tell you to lift with your legs. If a weight is too heavy to lift in this manner get some help or use a crane. You back is quite strong and difficult to injure if it is straight (flat) but easily injured if bent.



There is another 'back injury' movement that should be mentiond at the same time. Do not lift and then twist at the waist to set down a weight. Many people, especially when lifting material onto a counter or truck, will lift the weight correctly and then, instead of moving their feet toward the counter, will merely swing their upper body at right angles (90°) to the hips.

People have hurt their backs doing this with no weight, but weight certainly increases the possibility of injury if handled in this manner.

8. Maintain Electrical Wires!

Breaks and cuts in extension cords or power tool cords should be repaired and taped. If possible use tools and cords with three wires (one is a ground wire), otherwise ground the tool or cord directly to a water line, ground rod, etc. especially if you're working in dampness or with your feet on wet ground. Don't allow yourself to be the ground wire - it could kill you.

Always use the proper size of wire (when in doubt use the heavier); a cord which is too fine (light) for the load it is carrying may get very warm and overloaded electrical wires have started serious fires. Undersize wires will not carry enough current to a machine and will damage the motor.

9. Keep Working Areas Reasonably Clean!

Reasonably clean means use your common sense. Too much time spent picking up bits of wood, paper, etc. will annoy employers.

Especially clear areas around machines and work areas where you are using portable power tools. If you slip on snow or ice, or trip on lumber or a pile of sawdust it is quite possible that your hand could slip into a saw blade or you could fall and drop a spinning skilsaw onto your leg.

10. Stay Alert

If a worked is tired and not paying close attention, he/she is more likely to have an accident. Any time a procedure becomes automatic (the worker is no longer thinking about what they are doing) there is an increased chance of injury as the worker will not notice any changes which may have occured.

An example of this is when cutting many strips of wood to the same width on a table saw. The worker will eventually get to the point where he/she places his hands automatically in the correct position and pushes the board into the saw. They may not notice a large knot in the next strip of wood. This board could break at the knot and send pieces flying causing an injury.

Close calls should be considered a warning that proper procedures are not being followed or the worker is not paying attention to their work.

Complete the following questions and send them in to be marked.

EXERCISE 1

1. A worker just cut his hand with a chisel. List two possible reasons why this accident happened.

   (a) ______________________________

   (b) ______________________________

2. Two labourers were working close together. One was using a cold chisel and hammer to clean excess concrete from around a beam. A chip broke off and the other man was hit in the eye. What was the unsafe act?

   ____

   ____

3. One worker had been sanding drywall when he began to get a pain across his upper back. He also began to wheeze and cough up bits of material from his throat and lungs.

   (a) What was the unsafe condition?

   ____

   (b) What was the unsafe act?

   ____

   (c) How could this situation be corrected?

   ____

   ____

4. A worker was beginning to lift a wall up into place when he felt a sharp pain in his lower back. He had to drop the wall back onto the floor.

   (a) Was this an unsafe act or an unsafe condition?

   ____

   (b) What was the unsafe act or condition? Explain.

   ____

   ____

5. A carpenter noticed that the circular saw he was using had very little power and was kicking out the circuit breaker in the power panel. He decided to pull the plug from the wall outlet and check his extension cord (30 m long). He discovered the plug was hot and so was the cord up to 1 m from the plug. What was the most likely problem?

____

____

6. Why would glare from the lights in a work area be considered a hazard?

____

____

7. A worker considers himself 'accident prone'. What do you consider 'accident prone' to mean?

____

____

____

8. Close calls as far as accidents are concerned should be a warning to the worker. What kind of warning should they be?

____

____

____

9. Safety is combination of operator common sense and good work habits. What does this statement mean?

____

____

____

10. A worker should make it a habit to never walk under a suspended load. Why?

____

____

11. Why is it an extremely poor practice to walk up behind a worker and tap him on the shoulder to get his attention?

____

____

12. List one reason why unsafe acts cause 88% of accidents and unsafe conditions only 10%.

____

____

13. Why should you never operate a machine until you have been given a demonstration on how to operate it?

____

____

14. Why are safety glasses or goggles a necessity in most construction jobs?

____

____

15. One day a worker was cutting a 35 cm long board in half with a skill saw. As he cut the board he sawed into the fingers of his left hand.

    (a) What was the unsafe act?

    ____

    (b) What would have been the proper way to cut this board?

    ____

EXERCISE 2

1. Why is it important to keep work areas clean?

____

____

____

2. What three checks should be made on a ladder itself before using it?

    (a) ____

    ____

    (b) ____

    ____

    (c) ____

    ____

3. What does lifting with a flat back mean?

____

____

____

4. In order to see how closely a table saw is cutting a sheet of plywood in half, a carpenter removes the blade safety guard. List two dangerous results which could occur from this.

____

____

____

____

5. A worker wants to use an electric drill for drilling holes through a damp concrete basement floor. His drill has a three prong electrical connector plug but the extension cord he is using has only two prongs. The worker removes this third prong from the electric drill cord in order to use it with the two prong cord. What dangerous act is being committed and what could result from it?

____

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____

END OF LESSON 9

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ADHESIVES AND COATED ABRASIVES

Adhesives
Coated Abrasives

ADHESIVES

1. Introduction

Adhesives are fast becoming a very important fastener in industry. The number of adhesives has been increasing rapidly with the introduction of space age technology into the adhesives field. One example of how strong modern adhesives are is demonstrated by the fact that the metal skin of ultrasonic aircraft is glued on. Another is the fact that automobile and truck bodies are being glued instead of welded or bolted.

But everyone should be cautioned that they cannot put blind trust in just any adhesive product. Many of the new glues are fully as strong as claimed but there are some jobs they simply won't do. Many of them are designed for adhering certain materials together, but won't work on other materials. There is no such thing as a 'universal' or anything-to-anything adhesive yet invented.

One of the odd facts about these new adhesives is that no one really knows why they stick so strongly. There are several theories and each theory makes sense. The right answer may be a combination of all theories but at the moment no one can say for sure.

Much of the advance research in adhesion is happening in the laboratories of molecular chemists, specifically polymer chemists. A polymer is a group of molecules joined together in a chain, ring, or a more complex interwoven form. A polymer chemist is a man who has various ways of joining molecules so as to create new substances with useful properties. Professor H. Mark of the Polytechnic Institute of Brooklyn states one of the key properties of new adhesives is their ability to wet surfaces thoroughly. A good epoxy adhesive will flow into every sub-microscopic nook and cranny of the surfaces it is supposed to join. Old time glues didn't do this. If you spread some of the old-time glues on a surface and look at a cross section of the surface under a microscope, you'll see places where the glue has bridged across openings instead of sinking into them. In other words, the glue does not touch the entire surface and, naturally, where it doesn't touch, it doesn't stick.

All solid surfaces are very rough and rugged if we go down to molecular dimensions. The most carefully polished surface, the smoothest surface man can make, still has hills and valleys 70 times the size of a water molecule. To be really strong an adhesive must completely wet every hill and valley.

Adhesion usually takes place partly because of the very roughness in surfaces. The adhesive forms itself around bumps and holes in the surface, dries into a solid material, and is thus locked in place. This is called the 'mechanical action of adhesive'. While all adhesive experts agree that this is a part of the story, there is no agreement on how important a part.

Another set of theories concentrates on the elemental forces that hold molecules themselves together. When an adhesive sticks to something, what may actually happen is that a complicated interaction takes place between the molecules of the adhesive and those of the surfaces. The two groups of molecules become linked together by the same massive forces that bind a chain of atoms into a molecule.

If this were true, a glue joint could be as strong as the materials being glued. Many scientists believe this fact.

Flour and water pastes are pretty good at wetting surfaces. It flows into holes fairly well and binds itself into the surfaces it's joining. But a blob of dried school paste can be crumbled between your thumb and finger, and no flour paste joint can be any stronger than that. By contrast, a blob of modern epoxy is tough as a piece of metal. To give you some idea of how the exotic adhesives are used today, an epoxy resin solved a frustrating problem for the engineers of the White Sands Missile Range. Every time a test rocket was fired the concrete launching pad had to be rebuilt. Concrete can't stand temperature of much over 500°C without crumbling, and the exhaust gases of the coolest rocket are well over 2500°C. Naturally, on every blast-off a hole was made in the launching pad. Then the pad had to be resurfaced. The engineers finally tried gluing down firebricks with a special heat resistant epoxy adhesive. Several dozen test rockets have been lifted off this pad and it is still solid as the day it was built. Curbing on highways is an expensive proposition and usually costs about $7.50/m of curb. In California the highway planners bonded the curbing to the existing road with epoxy resin at a cost of $3.00/m of curb. Despite years of sun, rain and wild drivers, the curbing is still in place today.

Glue is rapidly replacing nails in the tedious job of attaching panelling to the studs of a house. This reduces labour 50% and eliminates the problem of nailheads popping out later when the house shifts or settles. A special line of adhesives have been produced to eliminate the high cost of nailing down floors. On the production line of window manufacturers, the production time has been reduced 50% by gluing the frame corners -- these are stainless steel window frames.

There is an office building in Connecticut that has been built entirely with adhesives, with the exception of some welded joints in the light steel frames. This building has not a single bolt, nail, or screw in it. The average new car contains some 12 kg of adhesive. These adhesives not only hold friction materials but also hold chrome trim, weather stripping, hood and deck linings, interior padding and upholstering and a dozen or more other components.

The scientific research has a long way to go in discovering the potential of many other adhesives. There is a curious kind of adhesive used by snails that is instant sticking and instant unsticking. Their slime holds them as long as they want to be held, and when they want to move they effortlessly unstick. Teflon is one of the slipperiest substances known and not even epoxy resin cements will stick to it tightly. But snails can climb up Teflon even when it is vertical. This in itself is a unique demonstration of adhesion. The snails were allowed to crawl around this Teflon coat for several days and the surfaces covered with dried trails of slime. It was proposed to peel the slime off and analyse it to see what it was made of. But it wouldn't peel. It was so firmly adhered to the Teflon that only a hard scrubbing could get it off. Obviously nature has a lot to teach us about adhesion. New adhesives with specific properties are being developed one by one -- adhesives that will stick only to metal, only to wet surfaces, only to hot or cold surfaces. If the 'universal adhesive' could be found, and it would glue anything-to-anything under any circumstances, how would you unscrew the cap from the bottle?

2. Household and Industrial Adhesives Chart

This section will be covered in chart form. Carefully study the charts enclosed on pages 4, 5, and 6.

Before getting into the chart several terms should be clarified:

(a) Setting time is the period of time glue takes to harden. Fast setting and instantaneous adhesives are ideal for bonding objects that are difficult or impossible to clamp. If minor adjustments are necessary before the glue sets, use fast setting, not instantaneous setting glue.

(b) Curing time is the period of time it takes glue to reach maximum strength.

(c) Remember to check glues for water resistance. PVA adhesives (common white glue) is not water resistant and the glue joints will fail if it is exposed to moisture for a period of time.

(d) Surfaces must be clean and free of wax, grease, paint, or varnish if glue is to reach full strength.

Keep in mind that there may be several types of each of the glues listed in the chart. For example, there are regular epoxy glues and five minute epoxy glues. The five minute epoxy glue sets much faster than the regular epoxy.

Adhesive	**Acrylic** (not generally available in Canada)	**Acrylonitrile**	**Aliphatic** (yellow polyvinyl acetate)	**Belt-locking compound** (anerobic resins)
Sample brand names	3 Ton Adhesive	Pilobond	LePage's Sure Grip Franklin Aliphatic Glue LePage's Cabinet Maker's Glue	Locktite Lock N' Seal (temporary bond). Locktite Stud N' Bearing Mount (permanent bond). LePage's Permalok
Typical uses	For fast, extra-strong bonding of wood, metal, glass, outdoor furniture, used in boat building.	For metal, glass, fabrics, carpets and tents, boat sails; not recommended for furniture joints.	General purpose adhesive for furniture building and repair, cabinet work.	For locking threads of bolts and screws; will harden in absence of air between closely fitted metal parts.
Components	Two parts, liquid and powder; mix amount needed just before use.	One part liquid; ready to use.	One part, liquid; ready to use (generally in squeeze bottle).	One part, liquid; ready to use.
Application	Apply with brush, putty knife, or strip of wood, depending on job.	Apply adhesive to both surfaces; use brush for large jobs; for small jobs apply from tube.	Apply from squeeze bottle.	Squeeze from tube or bottle.
Setting and curing time	Sets in as little as 5 min; cures overnight.	Sets almost immediately; cures in 24-48 hr, depending on type and method of application.	Clamp for at least 45 min while it sets; cures overnight.	Sets in about 15 min; cures overnight for most bonds, in 24 hr for steel to steel bonds.
Strength	41.3 MPa	13.8-20.07 MPa	13.8-24.1 MPa	Red - max.; blue - med.; purple - low.
Flexibility	Rigid	Highly flexible	Rigid	
Waterproof	Waterproof	Waterproof	Water soluble; do not use on outdoor furniture.	Waterproof and resistant to gasoline, oil and other solvents.
Solvent	Acetone (nail polish remover)	Acetone (nail polish remover)	Warm water	Soap and water before hardening.

Adhesive	**Casein glues** (not generally available in Canada)	**Cellulose** (not generally available in Canada)	**Contact Cement**	**Epoxy**
Sample brand names	National Casein Co. No. 30	Duco Cement (clear) Ambroid (amber)	LePage's Gel Contact Cement, LePage's Prestite, 3M 30 Bond, 3M 10 Bond	LePage's 5 Minute Epoxy, LePage's Regular Epoxy, Devcon Clear Epoxy, Borden Epoxy
Typical uses	Traditional furniture glue; good for such oily woods as teak and lemon; good gap filler; will leave stain marks on redwood, softwoods.	For wood, mold work, china, glass, most fabrics. Check for usability on plastics by testing on small area.	For bonding laminated plastic to countertops.	For wood, metal, china, glass, most other materials. Especially good for bonding two dissimilar materials such as metal to glass.
Components	One part, powder; mix with water.	One part, liquid; ready to use.	One part, gel, or liquid, ready to use.	Two parts, both pasty or syrupy liquids; mix equal amounts just before use.
Application	Apply with brush, roller, or strip of wood, depending on the job.	Apply directly from tube. Use strip of wood to apply from can, Strength is increased by applying two coats to both surfaces, letting first coat set until gummy before applying second coat.	Apply with brush or roller to both surfaces.	Apply with strip of wood, putty knife, brush, or matchstick.
Setting and curing time	Clamp for 5-6 hr while glue sets; cures overnight.	Sets to 60 percent strength in 2 hr; cures to 90 percent in 2 days.	Allow cement to stand about 15 min before joining surfaces. Sets almost immediately.	Sets at room temp, 5 min to overnight; cures in 3 hr to several days. (Devcon UW cures at −17.8°C, 2-3 weeks).
Strength	22 MPa	2.41 MPa		13.8-23.4 MPa
Flexibility	Rigid	Moderately flexible	Moderately flexible	Rigid to semirigid
Waterproof	Moderate; not waterproof.	Waterproof	High	Waterproof
Solvent	Warm water	Acetone (nail polish remover)	Acetone (nail polish remover)	Acetone (nail polish remover) Not easily removed; use expendable brushes.

Adhesive	**Hide glue, flake** (not generally available in Canada)	**Hide glue, liquid**	**Hot-melt**	**Latex-base adhesive** (not generally available in Canada)
Sample brand names	Usually carries retailer's name.	LePage's Strength Liquid Glue	Thermogrip Hot Melt, Swingline Hot Melt Bostich	Devcon Patch, Sears Stitchless Mender, Duralite Formula 55, Franklin Indoor/Outdoor Carpet Adhesive
Typical uses	For construction and repair of wood furniture.	For construction and repair of wood furniture.	For everything but a few plastics. Good for quick repairs on leather and fabrics; good gap filler for loose furniture joints.	Fabrics, cardboard, paper, carpet.
Components	One part, flakes; soak until smooth and brushable in water heated to 54°C.	One part, liquid; ready to use.	One part, cartridges in stick form; place into chamber of an electrically heated gun.	One part, liquid, ready to use.
Application	Apply with brush; work fast—glue stiffens as it cools. Do not apply cold.	Apply with brush, roller, or strip of wood, depending on job.	Apply with electric glue gun.	Apply directly from tube; use brush or strip of wood to apply from can.
Setting and curing time	Sets and cures in about 8 hr at 21°C.	Sets and cures in about 8 hr at 21°C.	Sets and cures in 1-2 min.	Sets almost immediately; cures in about 1 hr.
Strength	22MPa	22MPa	1.7 MPa	1.7MPa
Flexibility	Rigid	Rigid	Moderately flexible	Flexible
Waterproof	Water soluble; do not use on outdoor furniture.	Water soluble; do not use on outdoor furniture.	Waterproof	Waterproof
Solvent	Warm water	Warm water	Acetone (nail polish remover)	Lighter fluid

Adhesive	**Liquid solder** (household cement with metallic particles for coloring effect)	**Mastic**	**Polyester**	**Polyvinyl acetate (PVA, or white glue)**
Sample brand names	LePage's Liquid Solder	Ruscoe Pan-L Bond, Franklin Construction Adhesive, Webtex 200 Accoustical Adhesive	Mastercraft Body Patch	Elmer's Glue-All, DuPont White Glue, Sears White Glue, LePage's Bond Fast
Typical uses	Bonds aluminum, tin, other metals and materials. Not to be used to solder electrical connections.	For ceiling, wall, and floor tiles, plywood panels, concrete, asphalt, leather, textiles.	For fiberglass boats; bonds fiberglass to wooden hulls.	For general household repairs, furniture, interior woodwork, paper, ceramics.
Components	One part, liquid; ready to use.	One part, either a water-base synthetic latex or a rubber resin; both are ready to use.	Two parts, resin and activator, mix just before using.	One part, liquid, ready to use.
Application	Squeeze from tube; apply to both surfaces and press together at once.	If in a can, use stick or notched trowel; if in a tube, fit tube into a caulking gun.	Add activator and brush on.	For small jobs use applicator on bottle; for large jobs, use brush.
Setting and curing time	Sets in 20 min; cures in 24 hr.	Sets in a few seconds up to 1 hr; cures in 24 hr.	Usually sets in less than an hour. Cures over a longer period. See instructions for type being used.	Sets in about 8 hr at 21°C; cures in 24 hr. Not good above 43°C. Softens at 71°C.
Strength	6.9 MPa	1.7MPa		22 MPa (tensile strength good, but will creep under steady stress.)
Flexibility	Moderately flexible	Flexible or rigid, depending on type	Rigid	Rigid
Waterproof	Waterproof	Waterproof	Waterproof	Soluble, do not use on materials to be exposed to water.
Solvent	Acetone (nail polish remover)	Usually mineral spirits. Follow instructions for type being used.	Acetone (nail polish remover). Not easily removed; use expendable brushes.	Soap, warm water.

Adhesive	Polyvinyl chloride (PVC, or household cement)	Resorcinol	Silicone sealant	Styrene butadiene (rubber base cement)
Sample brand names	Scotch Super Strength Adhesive, LePage's Household Cement	Elmer's Waterproof Glue, Weldwood Resorcinol	Dow Silicone Adhesive, General Electric Silicone Seal, LePage's Silicone	Black Magic (Black) Brite Magic (White)
Typical uses	For quick repairs and craft work, china, marble, glass, wood, porcelain, metal.	For extra strong wood repairs; outdoor furniture, boat building.	For caulking sinks, bathtubs, windows, doors. Also bonds tiles, glass, metal, porcelain, wood. May contain toxic ingredients; do not use in dishwashers or aquariums.	Versatile adhesive for use on metal, glass, many plastics; replacement of loose tiles, bricks; reattachment of wall fixtures to tile or metal walls.
Components	One part, liquid, ready to use.	Two parts, liquid and powder; mix only amount needed just before using.	One part, liquid; ready to use.	One part, thick paste; ready to use.
Application	Apply directly from tube or use wood paddle.	Apply with brush, roller, or strip of wood, depending on the job and area.	Apply directly from tube or can, using spatula.	Use spatula, putty knife or trowel on large jobs; apply directly from tube on small jobs.
Setting and curing time	Sets in minutes. Cures over a longer period. See brand applications.	Sets and cures in 10 hr at 21°C, in 6 hr at 26.5°C, in 3½ hr at 32°C.	Sets in 1 hr; cures in about 24 hr.	Sets and cures in about 48 hr.
Strength	Depends on material being bonded.	Up to 23.4 MPa.	1.4 MPa	Depends on material being bonded.
Flexibility	Flexible	Rigid	Flexible	Rigid
Waterproof	Waterproof	Waterproof	Waterproof	Waterproof
Solvent	Acetone (nail polish remover)	Cool water before hardening; cannot be removed after hardening.	Excess can be peeled or scraped from some materials.	Mineral spirits such as turpentine.

Adhesive	Superglue (cyanoacrilate, or instant adhesive)	Urea formaldehyde	Water-phase epoxy	
Sample brand names	Krazy Glue, Duro Super Glue-3, Sears Super Glue #3	Weldwood Plastic Resin Glue, Elmer's Plastic Resin Glue, LePage's Plastic Resin Glue	Dur-A-Poxy	
Typical uses	Bonds most non-porous plastics, metals, vinyl, rubber, ceramics, but not paper, cardboard, fabrics, and wood; not for use on polyethylene or teflon.	For extra strong furniture and cabinet repairs	Can be used as waterproof coating over masonry, as protection for painting in chimneys; also can be mixed into cement.	
Components	One part, liquid, ready to use.	One part, powder; mix with water as per instructions before using.	Two parts, both liquid. Mix equal amounts just before using.	
Application	Cautiously apply one or several drops directly from tube; do not get on skin as it bonds fingers together.	Apply with brush, roller or spatula, depending on the job.	Apply with brush or roll when used as waterproof coating; with trowel or putty knife when mixed with cement.	
Setting and curing time	Sets in seconds; cures in ¼ hr to 12 hr.	Sets in 9-13 hr at 21°C, cures in 24 hr.	Varies, see instructions for type used; sets and cures faster when mixed with cement.	
Strength	Up to 34.5 MPa	20.7 MPa		
Flexibility	Rigid to semirigid	Rigid	Moderately flexible	
Waterproof	Highly water resistant	Highly water resistant after curing.	Waterproof after hardening.	
Solvent	Acetone (nail polish remover)	Soap, warm water before hardening.	Soap and water before hardening.	

3. Instructions for Commonly Used Adhesives

(a) Polyvinyl acetate emulsion glues (Bondfast, Ev-a-GRIP) are the most versatile adhesives for Builders, Arts and Crafts, and general household use. They are milky-white plastic glues with a number of advantages for general use. They are ready to use, simple to use, set fast, non-toxic (safe to use where children might have access to them), non-flammable, and produce strong bonds, having shear strengths in excess of 19 000 kPa. They do not stain, can be washed off with water while still wet, have good storage qualities, dry clear, and require little pressure to make a good bond. They make good bonds with wood, leather, paper, and cloth and are often used with plastic laminates. For wood, clamp 20 to 30 minutes with moderate pressure (the colder the temperature, the longer the drying time). They should be used at 15°C or higher. Although polyvinyl acetates are water resistant, they are NOT waterproof, so glued joints come apart if exposed to water for any length of time. This is the main disadvantage of these glues.

Listed below is the procedure for making solid joints using polyvinyl acetate glue (white glue).

(i) Both surfaces to be bonded must be clean and dry.

(ii) Apply a thin, even film of glue to each surface to be glued.

(iii) Join surfaces while still wet.

(iv) Clamp with moderate pressure for 20-30 minutes. It will achieve full strength in 24 hours.

(v) Since these glues are fast-drying, wash off excess glue and wash utensils immediately.

(b) Contact Cements (Neoprene cements) are widely used in construction today. They are used to bond plastic laminates (arborite, Formica, etc.) to wood countertops, shelves, doors, etc., and form excellent bonds with asbestos board, glass, and metals. They may also be used with leather, cardboard, sheet metals, and combinations of all of the above. Contact cements are used to cement gypsum wallboard, and other panelling to joists and studs. Another common use is laminated drywall (first layer of drywall is nailed on, the second layer glued on top of the first). Many neoprene adhesives are available in tubes for use in caulking guns and are called 'panel' adhesives.

Because they bond on contact and require no clamps, these glues are good for 'hard-to-get-at' corners and areas that are awkward or too large for clamps.

How to glue with contact cement:

(i) Make sure both surfaces are clean, dry, and warm (both glue and materials should be above 15°C).

(ii) Apply a liberal coat of glue to both surfaces to be bonded.

(iii) Allow to dry, usually 20 minutes (manufacturers say about 5 minutes to 1 hour, partly depending on temperature and humidity. Read their instructions on containers.)

(iv) Align both surfaces carefully and accurately as bonding is immediate upon contact. No adjustment is possible after contact!

(v) Once contact is made, apply pressure from the center and out toward the edges - never the reverse. If you apply pressure around the outside edges and work to the center of a sheet of plastic laminate or sheet metal, you will probably end up with large bubbles in the middle of the sheet. Pressure can be applied by tapping on a block of wood, rolling with a roller or rubbing with your clenched fist.

(vi) When top and sides of the job are all bonded, the edges and corners may be block planed down close to the finished edges (since plastic laminates dull cutting edges quickly you'll have to whet the plane iron often), and then filed smooth with a medium flat mill file, single cut.

(vii) When working with contact cements you must have some contact cement cleaner on hand because other solvents such as varsol or turpentine will not clean your brushes or other utensils nor take excess glue off the material. If contact cement becomes too thick for easy brushing, bring it back to its natural viscosity by adding a small amount of contact cement thinner.

Advantages:

(i) Since bonding is immediate upon contact, no clamping is required and further work can be carried out immediately.

(ii) Contact cements have excellent resistance to water and therefore are excellent to use around sinks, bathtubs, showers, etc.

(iii) They will bond a wide variety of materials together, wood, glass, metal, leather, etc.

(iv) You don't have to rush. You can make a bond up to 1 hour after the cement has dried.

Disadvantages:

(i) Since bonding is immediate upon contact no fitting is possible after setting in place. It must be aligned perfectly before contact.

(ii) Most quick setting contact cements are extremely flammable and hence work must be done away from any flame (including furnace pilot lights).

(iii) The quick drying contact cements are also extremely toxic and therefore good ventilation is required. NOTE: There are water base contact cements available that can be used where adequate ventilation is not possible. These can also be used on rubber, plastic, etc. which would be damaged by the solvents in other contact cements.

(c) Resorcinal resin glues (waterproof marine glues) are used whenever a fully waterproof adhesive is required for wood. Once set it is highly resistant to heat cold, fungus, mild acid, and mild alkali. It can safely be used where boats, furniture, etc. are exposed to extremes such as rain, snow, cold, heat, etc. These glues are usually supplied in two parts, a liquid with a separate catalyst which must be mixed just prior to use. Once the two parts are mixed they can be used up to four hours but it is best to use them within two hours. If the temperature drops below 22°C the glue will still harden but the joint will be weaker. Only the

amounts required should be mixed. The glued joint should be clamped at least 10 hours.

(d) Instructions for the use of other glues will be found on the glue package. Always make sure you read the instructions completely and are familiar with them before proceeding with the glue job.

4. Products Available for Everyday Use

Some of the new adhesives, such as plastic cement, polyvinyl acetate, contact cement, and epoxy, are more or less multipurpose glues and are good for general repairs. The others are designed for special uses. There are differences, though, among glues in the type of job they do best, how easy they are to use, and cost. Before deciding what adhesives to use, determine whether you need one with special quality. Must it be waterproof, boilproof, quick-setting, extra strong? Do you have to apply pressure to the joint or will you be able to apply pressure? Perhaps several will have the qualities you need. Then you can decide on the basis of cost and ease of use. For instance, using Lepage's Epoxy Glue (which is a fairly expensive glue and somewhat tricky to work with) to glue paper together, would be like hiring a moving van to take a book next door.

(a) Wood Glues

(i) Bondfast* Glue: The all purpose glue for wood, china, leathercraft, hobbies, plastic laminates - in fact almost anything in the house. Quick setting - 10 seconds for paper, 30 minutes for wood. Shear strength over 19 000 kPa. Dries transparent - stain proof. Non-toxic and safe for children to use.

(ii) Liquid Glue: The original Lepage's Strength Liquid Glue. Slower setting allows more time for do-it-yourself adjustments. The glue standard used by cabinet makers for fine woodwork. Excellent for leather and other porous materials. Shear strength up to 20 700 kPa.

(iii) Plastic Resin Glue: (Panite*) Urea formaldehyde adhesive powder - rotproof - stainless. For all wood gluing applications which require high water and solvent resistance.

(iv) Waterproof Marine Glue: Phenol - resorcinol - formaldehyde liquid resin, used with a powdered hardener. This combination produces an absolutely waterproof, boilproof, and fungus proof adhesive. Suitable for exterior and marine applications such as garden furniture, boats, sports equipment, etc.

(b) Contact Cement Family

(i) Pres-tite* Contact Cement: A premium grade Contact Cement for installing plastic counter tops, mounting utensil racks and curtain blocks, repairing leather suitcases, shoe sales, etc. Bonds most porous or non-porous materials. Bonds immediately on contact. Clamps are not necessary.

(ii) Contact Cement Regular Grade: Satisfactory for all normal Contact Cement needs.

(iii) Flameproof Contact Cement: Water-based formula - non-flammable. A must where solvent based cements damage the material to be bonded (e.g. plastics, natural rubber). Excellent spreadability. 1 L will cover 7 - 8 m^2.

(iv) Wallstrap Adhesive: Bonds woodstrapping to concrete or masonary. Quick and easy to apply - gives permanent installation.

(v) Panel Adhesive: Used to bond wood panels to wallstrapping. Eliminates nail holes, hammer dents, and panel warp. Saves up to 50% installation time.

(vi) New Wall Panel Adhesive: New Wall Panel Adhesive does five jobs: studs to concrete, panels to studs, foam to concrete, panels to foam, moulding to panels.

(vii) Contact Cement Thinner: Brings cement back to proper viscosity when evaporation has caused thickening.

(viii) Contact Cement Cleaner: Quick. Leaves brushes perfect for any use. Water rinse formula. Easily removes excess or spilled cement.

(c) Construction Products

(i) Ceramic Tile Adhesive: A water resistant, synthetic rubber adhesive which will effectively bond ceramic tile to gypsum wallboard, plaster, plywood, concrete, etc., and can also be used by hobbyists when constructing mosaic trays and tables.

(ii) Premium Butyl Caulking Sealant: A superior caulking, sealing and glazing compound. It provides an excellent, attractive, long lasting seal between similar and dissimilar surfaces. It is used for caulking and sealing windows, doors, rain troughs, downspouts, masonry joints, etc.

(iii) Foam Insulation Adhesive: A water resistant mastic foam adhesive and vapour barrier. It is suitable for bonding all types of insulation such as foamed polystyrene, foamed polyurethane, foam glass, cork, and other rigid insulating materials to most clean structurally sound surfaces.

(iv) Black-tite* Cement: Rubberized cement - economical for installing wallboard, floor coverings, tiles, counter tops, splashboards, foam insulating materials, cove moldings, etc. Edge retaining mouldings required.

(d) Fillers

(i) Plastic Wood: Natural colour - stains and paints like wood - waterproof - no separation - no shrinking or cracking.

(ii) Polypatch*: Amazing new filler that quickly fills holes in ceilings and walls. Mends all plaster and wood wallboard surfaces.

(iii) Tile & Tub Caulk: Waterproof - mends tiles, floor and wall and grouting around bathtubs.

(iv) Crack Filler: Fills small cracks, holes, and dents in plastered walls, drywall surfaces, and wood. Easy to apply and fast drying. It sands easily and is paintable.

(v) Plastic Steel: Best for that 'tough job'. Permanently repairs all metal articles, car fenders, etc. - waterproof - heat resistant. Will not rust, shrink, peel or crumble, and is not affected by water, oil or gasoline. Lepage's Plastic Steel is very fast drying and after it is set it can be sanded, buffed, polished, drilled, and tapped.

(vi) Plastic Aluminum: Especially researched for gap filling and heatless sealing. It solders, seals, and repairs. Will not rust, shrink, peel, or crumble and is not affected by water, oil, or gasoline. Lepage's Plastic Aluminum is very fast drying, and after it is set it can be sanded, buffed, polished, drilled, and tapped.

(e) Paint Remover and Brush Cleaners

(i) Dic-A-Doo* Two Minute Paint Remover: Non-flammable. Jellied for easy use on vertical surfaces. No after wash required.

(ii) Dic-A-Doo* Liquid Paint Brush Bath: Ready-to-use roller and brush cleaner. Efficient - contains more effective paint solvents. Can be reused time and time again. Best for hard brushes. Rinses out in water.

(iii) Dic-A-Doo Dry Brush Bath: The most efficient cleanser on market. Each pouch makes one quart of solution. Renews and restores dried brushes and reconditions bristles. Pleasantly scented.

(f) Wallpaper Products

(i) Stick-Fast* Wallpaper Paste Powder: Dry adhesive powder for all paper work. The finest quality product available for school, home, and industry. Non-toxic and safe for children to use.

(ii) Canco* Wall Size: Saves cost by sealing walls and wallboard before painting or papering. Easy to mix and to apply - very economical. Shows up hot spots.

(iii) Canco* Liquid Wallpaper Remover: Concentrated - removes standard and prepasted wallpapers. No waste - very effective for washing cars, windows and many other household uses.

(iv) Liquid Vinyl Adhesive: Stick-fast* Liquid Vinyl Wallcovering Adhesive is designed especially for adhering heavy vinyl coated fabrics to walls. It gives an excellent bond to dry, clean plaster, wood paper, and cloth surfaces. Bonds made with this adhesive resist humidity and mildew. Recommended for all leading Vinyl Wallcovering manufacturers.

(v) Dry Vinyl Wallcovering Adhesive: Dry vinyl wallcovering adhesive is designed especially for hanging light and middleweight vinyl, foil, and paper wallcoverings. Contains mildew-gard to protect and keep wallcovering beautiful and free from mildew. Comes in 3 handy sizes.

(g) Finishes, Water Repellent Preservatives, and Wood Stains

(i) Water Repellent Wood Preservative: A non swelling paintable water repellent preservative for wood. Penetrates to protect - does not merely seal the surface. Paint lasts longer and goes further when applied over treated wood. Protects against blistering, peeling, warping, and checking. Kills termites and prevents rot and mould. Available in clear, brown, or green - brown. Used when a rustic stain effect is desirable. C.M.H.C. approved.

(ii) Water Repellent Wood Stain: A penetrating water repellent decorative stain finish for wood. Protects and restores the beauty of wood. Will not blister, peel, crack, craze, or sugar. There are four stains - Redwood Hue, Rustic Brown, Cedar, and Clear. All can be blended and ground-in-oil colors may be added for an infinite variety of shades. (For walking or seating surfaces use Lepage's Furniture Stain).

(iii) Water Repellent Outdoor Furniture Stain: Satin Redwood furniture stain answers all past finish problems on outdoor or indoor wooden furniture - chalky rub-off is eliminated - cannot blister or peel. Protects by penetrating with superior water repellency. Provides a satin sheen finish that does not hide but enhances wood grain.

(iv) Neverwax: A polyester based floor finish that eliminates waxing and scrubbing. Dries to a tough finish.

(h) Specialty Products

(i) Rubber Padding Compound: Rubber adhesive preferred by printers and book binders for strength and flexibility. Make your own scratch pads and save.

(i) School and Stationery Items

(i) Mucilage: Canada's most popular adhesive for paper. Packed in the well known bottle with a gripspreader rubber top and in larger economy containers. Excellent for children's paper work.

(ii) Liquid Paper Paste: Always flows smoothly. Preferred by librarians for 'spot' paper gluing. Available in unbreakable, refillable squeeze bottles and economy refills. Non-toxic, safe for children to use.

(iii) Semi-solid Paper Paste: The best standard paste for scrapbook and paper work. Safe for children to use, non-toxic. Plastic spreader with 57 mL and 142 mL jars.

(iv) Paper Cement: Made to commercial artists' specifications for fine paper work. Wrinkleproof - standproof - waterproof. Excess rubs off on touch. Pure rubber base.

(v) Paper Cement Thinner: Saves expense by bringing Paper Cement back to proper viscosity when evaporation has caused thickening.

(vi) Wash-off Children's Glue: Safe - non-toxic. Spills can be washed up with soap and water. Ideal for gluing and light wood projects.

(j) Hobby Cements

(i) Plastik Cement: Specially researched model cement for hard plastics (polystyrene). Best for assembling model kits, mending toys and household articles. It is very strong, hot fuel proof, fast drying, and crystal clear.

(ii) Airplane Model Cement: Best for balsa wood models. It is hot fuel proof, extra fast drying, quick penetrating, very strong, and crystal clear.

(k) Specialty Household Products

(i) Regular Epoxy: Mends everything in bronze, copper, iron, steel, aluminum, most plastics, boat fixtures, etc. It has been formulated to safeguard the consumer from intricate compounding. Waterproof, shrinkproof, and expansion proof. Easy mixing procedures. Epoxy Glue is 100% adhesive. It cures by chemical reaction and not by loss of solvent.

(ii) 5 Minute Epoxy: It is easy to use, makes a super-strong bond, sets in 5 minutes and even works in freezing weather (at 0°C in 10 minutes and at -10°C in 3 hours). It is waterproof.

(iii) Household Cement: The top hobby cement for all craft work, shell, and leather craft, etc. Best for general repairs around the house and workshop. Crystal clear - waterproof.

(iv) Vinyl Plastic Repair Cement: Is researched to mend and repair such vinyl plastics as wading pools, beach balls, inflatable toys, shower curtains, car seat covers, etc. It can also be used to cement vinyl to metal. Because of its viscosity it will form a film to mend small punctures and tears without patches. Patching material is included for large and ragged tears. Can be used under water.

(v) China-weld: An exclusive Lepage's formulation to answer demands from the consumer for boil proof repairs of china and ceramics. Easy to use and fast-drying product. Now you can save that special cup and saucer, fine china vase or ceramic ashtray - and wash it in boiling water with complete confidence.

(vi) Leather Cement: For all leather, rubber, neolite, and canvas repairs. It bonds in 5 minutes, stays flexible, and is waterproof.

(vii) Miracle Mender: A 'liquid plastic' mender for fine china, vinyl toys, jewelry, and ceramics. Excellent for many household repairs. It waterproof, clear, super strong.

(viii) Fabric Cement: New, drycleanable formula for permanent repairs to most fabrics. Use Lepage's Fabric Cement to: patch children's cloths, hem dresses and curtains, attach fringe to carpets and lampshades, mend pocket holes, attach sequins, applique, felt protection pads, trim feather hats. It mends tents, slip covers, overalls, corduroy, felt, and canvas. In fact it will repair almost any fabric, rip or tear. Fabric cement is boilable, washable, and ironable.

COATED ABRASIVES

Coated abrasive sheets refers to all the varieties of sandpaper and emery cloth. The term abrasive includes grinding wheels and dishes, oil stones, and coated abrasives - any sharp, hard material, that wears away a softer material when the two are rubbed together.

The idea behind using sandpaper is to start with an abrasive size that will be slightly smaller than the scratches or bumps on the material to be smoothed (so the result will be a smoother finish) and then if necessary gradually work to finer and finer abrasives until the finish is as smooth as required. Remember, if you go to a fine abrasive too early, it will be more difficult to remove the irregularities.

In order to fully understand coated abrasives we have to take a look at the parts used to make them up.

1. Abrasive grains

There are several abrasive materials used. The type of abrasive used will help determine how long the abrasive will last, how much it will cost, and what types of material it can be used on.

Below is a list of the types of abrasives commonly used by carpenters and some important information on each one.

(a) Flint (called Flint paper)

It is gray-tan in color. This is a natural material (it is made from quartz). It is low in cost. However, it lacks the toughness and durability of other abrasive materials and hence wears down quickly. Its use is being discontinued and at present may be difficult to buy.

(b) Garnet

This is a naturally occurring mineral. It is reddish-brown in color and is widely used in the woodworking industry for hand and machine sanding. It is much harder and more durable than flint. It is the abrasive most commonly used by carpenters for sanding wood.

(c) Aluminum oxide

Aluminum oxide is a synthetic (meaning man-made) material made in an electric furnace from aluminum ore. It is harder and slightly tougher than garnet although more expensive. Aluminum oxide is used extensively on sanding machines as it will outlast garnet. However, the aluminum oxide particles are not quite as sharp as garnet and hence even though they last longer than garnet, they require more effort in sanding. For this reason aluminum oxide particles have not replaced garnet entirely.

Aluminum oxide is most commonly used for sanding wood although it can be used for sanding ferrous metals (metals containing iron).

(d) Silicon Carbide

Silicon carbide is another synthetic material. It is blue-black in color. It is sharp, brittle, and hard. In fact, silicon carbide is almost as hard as a diamond. Also, as the abrasive particles wear, they fracture (break) exposing new needle sharp particles for fast stock removal.

Silicon carbide abrasives are not as frequently used by carpenters as aluminum oxide or garnet sand paper. Silicon carbide abrasives are used in sanding glass, plastics, leather, aluminum, brass, copper (non ferrous metals) as well as on lacquered and enameled surfaces. The silicon carbide abrasives are usually made with waterproof backing and adhesives for sanding with lubricants such as water, kerosene, Swedish oil, and liquid grinding lubricants. The lubricants keep the surface of the abrasives from loading (plugging up).

(e) Emery (emery cloth)

Emery crystals occur naturally. They are black in color. Emery has good polishing action on most metals. They are not recommended for use on wood because of poor stock removal. Its primary use is for removal of rust from tools.

Abrasive particles come in various sizes. The size is determined by the size of screen that the grit is shifted through. The screen size varies from 12 (very coarse) to 600 (very fine).

The 50 grit is considered coarse to a carpenter doing general sanding on wood. The 220 grit is usually as fine as one would use on wood before finishing with stain or varnish.

Once the first coat of varnish is applied then the finer grades are used between coats.

It should be noted that sandpaper coarser than necessary should not be used as this will make the wood rougher and lead to extra work.

2. Backing for Abrasive Particles

(a) Paper

The standard sheet sandpaper used by most carpenters has a paper backing. The paper backing comes in five different weights, A,B,C,D, and F. A weight is the lightest and is usually used on fine sandpapers. D weight is the heaviest a carpenter will normally encounter and it is used on the coarsest sandpapers.

(b) Cloth

Cloth backings come in different weights as well (J,X,Y,S). Cloth backings have greater strength and flexibility than is possible with paper backing. Cloth backed abrasives are primarily used on power belt sanders. Cloth backing is also used on sheets of emery abrasive and hence the common name - emery cloth. J is the lightest weight and S is the heaviest.

(c) Fiber backing

These consist of several layers of special paper bonded together. They are tough and strong for high speed drum and disk use where heat is a problem.

(d) Combination backing

A fiber/cloth combination backing is often used on sanding drums. This backing is stronger than fiber backing.

3. Bonding

The adhesives which bond the abrasive grain to the backing are applied in two layers.

The first layer is the called the 'make coat'. It is applied to the paper or cloth backing so that as the backing is coated with abrasive particles the particles will stick.

The second layer, called the 'size coat', is applied over the abrasive particles and ensures the particles are locked onto the backing material.

There are several materials used to bond the abrasive particles to the backing

(a) Glue

Glue bonded coated abrasives are the most common.

In glue bonded products, hide glues are used. Glue-bonded products have low resistance to sanding heat but provide superior finishes. These are not waterproof and dampness will dissolve the glue.

(b) Resin

Resin bonded abrasives have more strength, resistance to heat, and resistance to grain shedding. This bond is used in heavy duty disks and drums.

(c) Waterproof bonds

These are used along with waterproof paper to make wet and dry sandpapers which can be used with water to prevent clogging of the sandpaper when sanding finishes.

4. Abrasive Grain Coatings

There are two systems used for coating the backing with abrasive particles. They are:

(a) Open Coat

This means that the individual grains are set at a predetermined distance apart and cover 50-70% of the backing surface. Open coat sandpaper does not clog as quickly. It is used (especially for first sanding) on large power floor sanders and edge sanders when refinishing painted or varnished floors. It is also used by the home handyman for sanding paint where clogging may be a problem. The following terms may be printed on the back of sandpaper to indicate it is open coated: openkote, open-coat, flexbac, open, or o/p.

(b) Closed Coat

This means the abrasive particles cover the entire area of the backing. The greater number of abrasive particles causes faster stock removal. It is recommended where loading (clogging) is not a problem and where a smoother surface is desired.

Close coat is considered the standard type so if nothing is printed on the back the sandpaper will be closed coated.

5. How to Use Coated Abrasives

(a) Choice

The labels on sandpaper yield a great deal of information.

(i) trademark, (3 M, Bear brand, etc.)
(ii) used name (tri-m-ite, Durite, etc.)
(iii) type of abrasive (garnet, aluminum oxide, etc.)
(iv) abrasive particle size (grit number i.e. 400)
(v) backing (unless standard paper)(cloth, fiber, combination)
(vi) backing weight (A,B,C,D,F, or J,X,Y,S)
(vii) open or close coat - OP will be on the label if open coat (nothing on the label if it is closed coat or standard).

(b) Sizes

In Canada sheet sandpaper is usually packaged in sleeves of 50 or 100 sheets, each of which are 228 mm × 280 mm. Individual sheets, quarter size sheets, or packages of mixed fine, medium, or coarse sheets are also available but the cost is greater.

Sandpaper can also be purchased in various sized disks, drums, belts with paper, cloth, or combination backings.

(c) Using coated abrasives:

(i) Sand with the grain.

(ii) Sand only after edge tool operations are complete (grit in the wood will dull tools). However, sanding may be much easier before a project is glued and nailed (or screwed) together.

(iii) Sanding across the grain cuts in scratches that you may not be able to remove. Sand with the grain only.

(iv) Scratches show up much more after a clear finish has been applied. It 'brings them out'. Carefully inspect a project for scratches if it is to be coated with a clear finish (varnish). Remember any scratches that can be noticed before finishing will show up (stand out) much more after finishing.

(v) Start with coarser sandpaper (if required) and finish with a finer grade.

(vi) Since the sandpaper grit gradually fills up with wood particles, occasionally tap it against a hard surface to dislodge the particles.

(vii) For hand sanding tear (bend and then tear over a square corner) the sheet into four equal parts. A sanding block helps to reduce the problem of rounding corners while sanding and helps to keep a surface flat.

(viii) When sanding concave edges wrap the sandpaper around a piece of dowel or other cylindrical object. For convex surface sanding use a piece of sandpaper and curve your hand to match the surface.

(ix) Watch for particles and chips between the sandpaper and sanding block. They form small hard surfaces which will make the sandpaper leave scratches and gouges in the surface.

(x) You may find that the bottom of your sanding block is too hard and is leaving marks. To obtain a soft surface glue a piece of rubber, rug underlay, etc. to the bottom of the block. This is especially important when sanding surfaces to which a finish has been applied. Here you want the entire surface sanded not just the high spots. Hence foam allows you to cover the entire surface so the next coat will adhere better.

(d) Flexing

Sandpaper can be flexed by drawing it (backing down) over a square corner. This produces a controlled breaking of the adhesive bond. This makes the sandpaper more flexible and hence it has less tendency to crack or tear (this is especially true of the coarser sandpapers). Since flexing tends to increase abrasive particle shedding, no more flexing than necessary should be done.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. There are several theories on the way that adhesives work. List two of these.

   (a) ______________________________

   (b) ______________________________

2. Why does epoxy glue form a stronger joint than a flour-water paste?

   ____

   ____

   ____

3. In the strength column on the "Household and Industrial Adhesives" chart, what does the abbreviation MPa stand for? (Hint: It is a metric unit.)

   ____

4. Why is the LePages 'Bond Fast' (white glue) not recommended for use where there will be a large constant pressure on it?

   ____

   ____

   ____

5. Of the glues listed in the chart, enclosed which one is most commonly used by carpenters for gluing woodwork which will remain indoors?

   ____

   ____

6. Why is 'Krazy Glue' not suitable for gluing wood projects together?

   ____

   ____

7. Resorcinal is one of the more common glues used for outdoor applications.

   (a) What form is it in when you buy it?

   ____

   (b) Describe the procedure used to clean up the spilled glue before it sets.

   ____

   ____

   (c) Can it be cleaned up after it sets?

   ____

8. Explain how to make a good glue joint with polyvinyl acetate glues.

(a) ______________________________

(b) ______________________________

(c) ______________________________

(d) ______________________________

(e) ______________________________

9. List three reasons why contact cement is considered an excellent adhesive for fastening arborite to counter tops.

(a) ______________________________

____

(b) ______________________________

____

(c) ______________________________

____

10. Why do you apply pressure from the center outward on the sheet of arborite when contact cementing it to a counter top?

____

____

____

11. LePage's now makes a glue called 'Cabinet Makers Glue'. It is a Polyvinyl acetate glue. How does it differ in properties from LePage's 'Bond Fast' glue? List two ways.

(a) ______________________________

____

(b) ______________________________

____

12. List four articles which can be repaired with vinyl plastic repair cement.

(a) ________________ (c) ________________

(b) ________________ (d) ________________

EXERCISE 2

1. What does the term 'coated abrasive' mean?

2. What will the results be of the going from a coarse abrasive directly to a very fine abrasive when sanding a project?

3. List the two most common abrasives used by carpenters for sanding wood.

   (a) ______

   (b) ______

4. Which of the abrasives covered are synthetic (man-made)?

   (a) ______

   (b) ______

5. When sanding a rough spot on a piece of wood you decide to start with 50 grit garnet and sand with the grain until only sanding scratches from the sandpaper are left. You use 100 grit and then 150 grit sandpaper and so on. What would be the finest grit you would have to go to before the wood is ready to finish?

6. Silicon carbide abrasives often have waterproof backing and bonding as they are often used with ______

7. Which weight of paper backing for sandpaper is the lightest?

8. What is the advantage of cloth backing over paper backing for sandpaper?

9. Which type of bonding is most commonly used for sheet sandpaper?

10. Why are the abrasives on some sanding disks and drums resin bonded instead of glue bonded?

____

____

11. Define the term open coat sandpaper.

____

____

____

12. Using the sandpaper samples which were sent to you with Lesson 6, fill in the following chart.

Samples				
	1	2	3	4
(a) Manufacturer (trade mark)				
(b) used name				
(c) grit size				
(d) type of backing				
(e) weight of backing				
(f) type of abrasive				
(g) open or closed coat				

END OF LESSON 10

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________________

Time Spent on Lesson ____________________

(If label is missing or incorrect)

File Number ____________________

Lesson Number __________

Student's Questions and Comments

Apply Lesson Label Here

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Assigned Teacher: __________

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Assignment Code: __________

Date Lesson Received: ____________________

Lesson Recorded __________

Teacher's Comments:

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Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

TRADE MATHEMATICS I

In this lesson you will study the addition and subtraction of whole numbers, mixed numbers, decimals, and fractions.

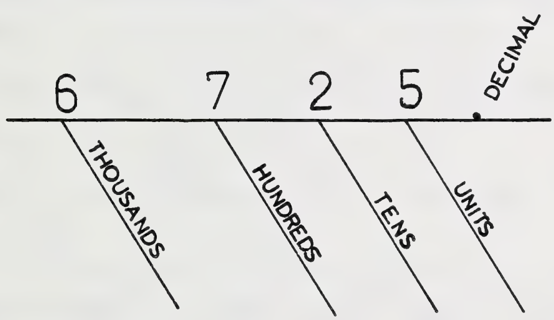
You may think that mathematics is not a tool to be used in building construction but, an error in mathematics can cause a serious mistake just as a dull saw or plane. It is important to keep your mathematics skills just as 'sharp' as you would keep any other tool.

Throughout this lesson 'self-correcting exercises' are included. If you are weak in Math it is strongly recommended that you honestly do all the exercises. However, if you are very good in Math then there is no point in wasting your time with the 'self-correcting exercises'. Go directly to the lesson exercises that must be done. Answers to the 'self-correcting exercises' are listed on page 24.

ADDITION OF NUMBERS

1. Naming the Numbers

For a quick review of how numbers are named, study the illustration below which shows a set of numbers located on a line with their place values indicated. Every numeral has a decimal point associated with it. If no decimal values appear to the right of where the decimal point should be, then there is no necessity for the decimal point itself to be indicated. In fact, most numerals are written without the decimal.



2. Addition of Whole Numbers

Since you have decided to take this course it has been assumed that you are able to add whole numbers. Answer the exercise on the next page if you think you may have troubles adding whole numbers.

SELF CORRECTING EXERCISE 1

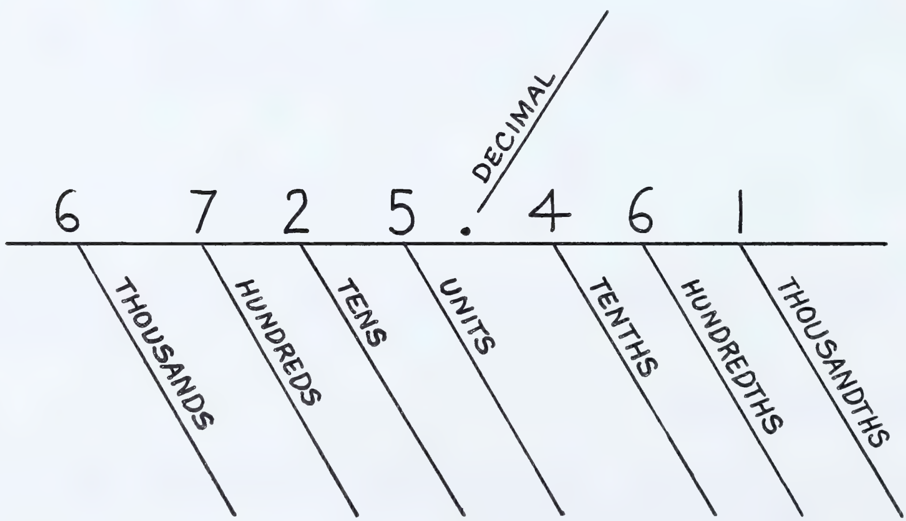
1. Add the following.

(a)	(b)	(c)	(d)
3	16	387	1097
5	9	481	210
7	27	963	9109
9	41	17	92
6	43	888	888
5	19	24	8
8	3	911	6017
4	20	4	
		216	

(e)	(f)	(g)
7879	9898	7075
8757	1111	8925
9799		

3. Naming the Decimal Numbers

The diagram from page 1 is repeated below but decimal values are also included.



Please notice the following facts about the diagram on page 2. First, every value to the left of the decimal has a corresponding value to the right of the decimal, except for the units.

Secondly, every value to the right of the decimal is denoted by a word ending in -ths. Thus, there are tenths, hundredths, thousandths, etc.

When a numeral which has both whole and decimal values is named, the position of the decimal has to be denoted. As decimal values are really fractions, mathematicians use the naming system as is used with fractional values.

Thus, $6\frac{3}{10}$ is named 'six and three tenths'.

4.7 would be named as 'four and seven tenths'.

In this way the word 'and' will always denote the decimal point.

SELF CORRECTING EXERCISE 2

Name the following decimal numbers.

967.41 is named

nine hundred sixty seven and forty one hundredths

3.99 is named

____

60.02 is named

____

391.627 is named

____

200.202 is named

____

191.056 is named

____

1 001.001 is named

____

In the building trades, the word 'decimal' or 'point' are frequently used to denote the decimal location.

Redo the above exercise using either of these words to locate the decimal. Space is given on the next page.

SELF CORRECTING EXERCISE 3

967.41 is named

nine hundred sixty seven decimal four one

3.99 is named

____

60.02 is named

____

391.627 is named

____

200.202 is named

____

191.056 is named

____

1 001.001 is named

____

When we have a value which is only a decimal value, with no whole numbers, the decimal is sometimes lost. To avoid confusion, a zero is placed before the decimal, which will warn us of the existence of the decimal.

EXAMPLE: 0.5, 0.627, 0.991

4. Adding Decimal Numbers

In ordinary addition we put the numerals in a column, one numeral above another, with the place-values directly above one another. Thus, units are above units, tens above tens, and so forth.

This same system is used when decimal values are used, tenths are placed above tenths, hundredths are placed above hundredths, and so forth. The example below illustrates this statement.

EXAMPLE:

```
  1.1
 21.12
321.123
343.343
```

From this example a simple rule of addition can be stated.

> When adding decimal numerals, keep the decimal points in a column directly above one another.

When we add whole numbers, we find that 10 ones are 10, and 10 tens are 100. So we simply 'carry over' the second digit as in the following example.

EXAMPLE: Add:

$$\begin{array}{r} 6 \\ 2 \\ \underline{7} \\ 15 \end{array}$$

If there were any values in the tens column, the 1 ten would be added into it.

EXAMPLE: Add:

$$\begin{array}{r} 6 \\ 22 \\ \underline{7} \\ 35 \end{array}$$

The same procedure will hold for the decimal values, because 10 tenths are one unit and 10 hundredths are one tenth. So in adding decimals, we can simply 'carry over' into the next column to the left, as in ordinary addition, and this includes 'carrying over' across the decimal point.

EXAMPLE: Add:

$$\begin{array}{r} 0.3 \\ 0.5 \\ \underline{0.9} \\ 1.7 \end{array}$$

Note that the 1 has been carried over into the units column.

SELF CORRECTING EXERCISE 4

ADD:

1. (a)
$$\begin{array}{r} 26.9 \\ 31.7 \\ 52.2 \\ 38.4 \\ 11.1 \\ \underline{29.8} \end{array}$$

(b)
$$\begin{array}{r} 171.92 \\ 36.8 \\ 421.09 \\ 200.17 \\ 18.18 \\ \underline{991.09} \end{array}$$

(c)
$$\begin{array}{r} 1070.301 \\ 21.16 \\ 197.003 \\ 9191.101 \\ 462.31 \\ \underline{1.9} \end{array}$$

In the next three problems arrange the numbers into columns in the space below and add.

2. (a) 29.31 + 49.62 + 51.21 + 36.25 + 99.01
   (b) 129.902 + 67.311 + 7.021 + 18.977 + 201.007
   (c) 7.01 + 1916.399 + 1070.002 + 19.1 + 100.09

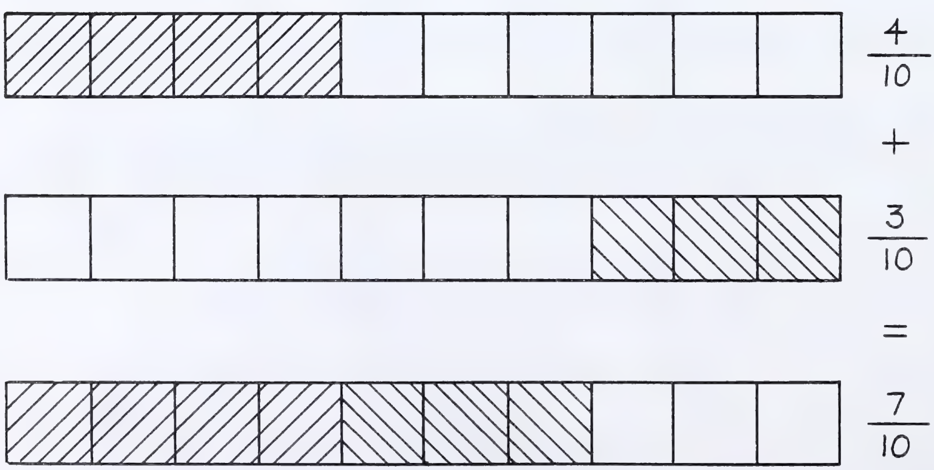
3. (a) Add twenty nine point three two plus sixty seven point nine one plus one hundred forty three point zero three.

   (b) Add one thousand point zero plus eighteen point one eight plus ninety two plus one hundred point nine zero two.

5. Adding Fractional Values

So far you have worked with decimal values. We call 0.4, four tenths, and this could be expressed as $\frac{4}{10}$ Similarily 0.32 is thirty two hundredths or $\frac{32}{100}$ and 0.109 is one hundred nine thousandths or $\frac{109}{1000}$.

When we use such a value as four tenths, we are really saying that we have divided our figure into ten equal sized portions and we are considering four of those portions. When we add four tenths to three tenths, we get seven tenths, as in the diagram below.



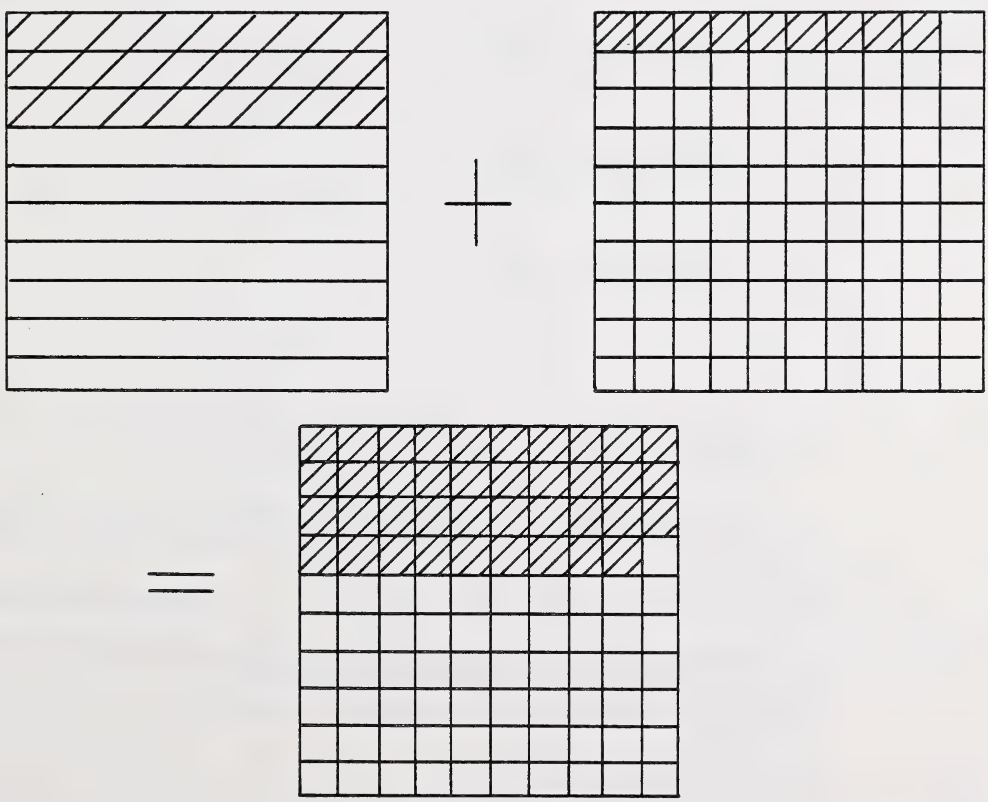
Notice in the diagram on page 6 that the value of $\frac{3}{10}$ has been moved next to $\frac{4}{10}$. We can do this simply because each one of our ten portions are the same size as any other one of our ten portions. This works fine so long as the portions are always the same size. Notice that the denominator of our fraction (the 10) gives us the size of the portion that we are dealing with.

But suppose we were to add $\frac{3}{10}$ plus $\frac{9}{100}$. Our denominators are different sizes (10 and 100) so the portions will be different. We cannot add the two fractions as they are given.

The solution to this problem would be to make the denominator the same size. We can do this by multiplying by 10 by 10 to get 100. At the same time we must multiply the 3 by 10 to get 30. We must do this so that we will keep the same size of the fraction given.

So $\frac{3}{10} = \frac{30}{100}$

Now we can add $\frac{30}{100} + \frac{9}{100}$ to get $\frac{39}{100}$



$$\frac{3}{10} + \frac{9}{100} = \frac{39}{100}$$

> When we bring fractions to the same denominator we say we have brought them to their Common Denominator.

SELF CORRECTING EXERCISE 5

Bring the following fractions to a common denominator and then add them.

1. (a) $\frac{3}{10} + \frac{32}{100} + \frac{109}{1000} = \frac{300}{1000} + \frac{320}{1000} + \frac{109}{1000} = \frac{729}{1000}$

   (b) $\frac{1}{10} + \frac{7}{100} = \frac{\quad}{100} \qquad =$

   (c) $\frac{7}{100} + \frac{99}{1000} =$

   (d) $\frac{1}{1000} + \frac{19}{100} + \frac{4}{10} =$

   (e) $\frac{707}{1000} + \frac{77}{100} + \frac{191}{1000} =$

   (f) $\frac{32}{100} + \frac{16}{100} + \frac{26}{1000} =$

When such fractions as these are added, we must also bring each fraction to the common denominator.

It would be convenient for us to note at this time that one fourth is half as much as one half, one eight is half as much as one fourth, and one sixteenth is half as much as one eighth.
(You can check this on your ruler, if you like.)

So, if you have to add a number of fractions of this nature, the largest denominator is automatically the common denominator of the group.

EXAMPLE:

Add $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$

$\frac{1}{2}$ is $\frac{8}{16}$, $\frac{1}{4}$ is $\frac{4}{16}$, $\frac{1}{8}$ is $\frac{2}{16}$.

So, with a common denominator of 16, we get

$$\frac{1}{2}+\frac{1}{6}+\frac{1}{8}+\frac{1}{16}=\frac{8}{16}+\frac{4}{16}+\frac{2}{16}+\frac{1}{16}=\frac{15}{16}$$

SELF CORRECTING EXERCISE 6

Add the following fractions.

1. (a) $\frac{1}{2}+\frac{3}{8}=\frac{4}{8}+\frac{3}{8}=\frac{7}{8}$

(b) $\frac{1}{4}+\frac{1}{8}=$

(c) $\frac{1}{8}+\frac{3}{16}=$

(d) $\frac{1}{4}+\frac{3}{8}+\frac{5}{16}=$

(e) $\frac{3}{4}+\frac{3}{16}=$

(f) $\frac{9}{16}+\frac{1}{8}+\frac{1}{4}=$

6. Naming Mixed Numbers

Assume you have the number $\frac{3}{2}$ The numerator is greater than the denominator.

We could separate the numerator into two divisions using this idea

$$3 = 2 + 1.$$

So our $\frac{3}{2}$ becomes $\frac{2 + 1}{2}$ or $\frac{2}{2} + \frac{1}{2}$.

Now $\frac{2}{2}$ is two parts of a thing which has been divided into two parts. This simply means $\frac{2}{2}$ is the whole thing or 1.

So our $\frac{3}{2}$ can be expressed as $1\frac{1}{2}$.

> Anytime a fraction has a numerator greater than its denominator, we should express that value as the sum of a whole number and a fraction. Such a sum is called a Mixed Number.

SELF CORRECTING EXERCISE 7

Express the following as mixed numbers.

(a) $\frac{11}{8} =$ (b) $\frac{7}{4} =$

(c) $\frac{31}{16} =$ (d) $\frac{17}{8} =$

(e) $\frac{5}{8} + \frac{5}{8} =$ (f) $\frac{3}{4} + \frac{3}{4} =$

(g) $\frac{7}{8} + \frac{5}{8} =$ (h) $\frac{13}{16} + \frac{17}{16} =$

7. Addition of Mixed Numbers

We have defined a mixed number as the sum of a whole number and a fraction. Suppose we were asked to add the quantities.

$3\frac{7}{8} + 4\frac{5}{8}$

We can say $3\frac{7}{8}$ is $3 + \frac{7}{8}$ and $4\frac{5}{8}$ is $4 + \frac{5}{8}$.

Now, our addition problem becomes

$$3 + \frac{7}{8} + 4 + \frac{5}{8}$$

and we can rewrite this as

$$3 + 4 + \frac{7}{8} + \frac{5}{8}.$$

Doing the simple addition we now get

$$7 + \frac{12}{8}$$

or

$$7 + 1\frac{4}{8}.$$

Note that $\frac{4}{8}$ can be expressed as $\frac{1}{2}$, so our correction answer is

$$7 + 1 + \frac{1}{2} = 8\frac{1}{2}.$$

We can now write our rule for adding mixed numbers.

Rule: To add mixed numbers, add the fractional numbers, expressing the answer in simplest form. Add the whole numbers.

SELF CORRECTING EXERCISE 8

Add the following mixed numbers, expressing the answers in simplest form.

(a) $\frac{3}{8}$

$\underline{\frac{4}{8}}$

(b) $4\frac{1}{8}$

$1\frac{5}{8}$

$\underline{\frac{7}{8}}$

$5\frac{13}{8} = 5 + 1\frac{5}{8} = 6\frac{5}{8}$

(c) $5\frac{7}{8}$

$\underline{16\frac{5}{8}}$

(d) $\frac{1}{4}$

$16\frac{1}{4}$

$\underline{7\frac{3}{4}}$

(e) $\frac{7}{8} = \frac{14}{16}$

$\frac{1}{4} = \frac{4}{16}$

$\frac{1}{16} = \underline{\frac{1}{16}}$

$\frac{19}{16} = 1\frac{3}{16}$

(f) $4\frac{1}{2}$

$\underline{2\frac{5}{8}}$

(g) $16\frac{3}{8}$

$\underline{24\frac{3}{4}}$

(h) $4\frac{5}{8}$

$3\frac{3}{4}$

$\underline{19\frac{9}{16}}$

SUBTRACTION OF NUMBERS

1. Subtraction of Whole Numbers

Subtraction is the inverse operation of addition. This is, it 'undoes' what addition 'does'. For this reason, many of the manipulations necessary in subtraction are similar, but opposite to those in addition. For example, in addition when we have more than 10 of any one value, we 'carry over' the 1 to the next column, and continue the addition. In subtraction, we can 'borrow' from the next higher value, as in the following example.

$$\begin{array}{r} 309 \\ -197 \\ \hline \end{array} = \begin{array}{r} {}^{2\;1}\cancel{3}09 \\ -197 \\ \hline 112 \end{array}$$

We can check our subtraction by simple addition.

$$\begin{array}{r} 197 \\ +112 \\ \hline 309 \end{array}$$

SELF CORRECTING EXERCISE 9

Perform the following subtractions.

(a) $\begin{array}{r} 2969 \\ -1731 \\ \hline \end{array}$ (b) $\begin{array}{r} 991 \\ -190 \\ \hline \end{array}$

(c) $\begin{array}{r} 3902 \\ -1771 \\ \hline \end{array}$ (d) $\begin{array}{r} 8000 \\ -7856 \\ \hline \end{array}$

2. Subtraction of Decimal Values

When we subtract decimal values, we must do as we did in addition, that is, keep the decimal points directly above one another. We can, however, 'borrow' across the decimal point as in this example.

EXAMPLE:

$$\begin{array}{r} {}^{1\,9\,9}\cancel{2}\cancel{0}\cancel{0}.19 \\ -\ 16.93 \\ \hline \end{array} = \begin{array}{r} 200.19 \\ -\ 16.93 \\ \hline 183.26 \end{array}$$

SELF CORRECTING EXERCISE 10

Perform the following subtractions.

(a) $\begin{array}{r} 971.9 \\ \underline{-318.6} \end{array}$ (b) $\begin{array}{r} 1316.66 \\ \underline{-1135.52} \end{array}$

(c) $\begin{array}{r} 88.907 \\ \underline{-73.546} \end{array}$ (d) $\begin{array}{r} 109.019 \\ \underline{-\ 99.109} \end{array}$

(e) $\begin{array}{r} 1009.901 \\ \underline{-\ 873.692} \end{array}$ (f) $\begin{array}{r} 1385.702 \\ \underline{-\ 947.444} \end{array}$

Notice that, in decimal values, we can put zeros to the right of the last digit to the right of the decimal point, without changing the basic value of the number. This is very useful in subraction.

EXAMPLE:

$$\begin{array}{r} 69.3 \\ \underline{-\ 31.287} \end{array} = \begin{array}{r} 69.300 \\ \underline{-\ 31.287} \\ 38.013 \end{array}$$

SELF CORRECTING EXERCISE 11

Subtract:

(a) $\begin{array}{r} 73.33 \\ \underline{-\ 69.39} \end{array}$ (b) $\begin{array}{r} 109.6 \\ \underline{-\ 72.43} \end{array}$

(c) $\begin{array}{r} 109.5 \\ \underline{-\ 44.671} \end{array}$ (d) $\begin{array}{r} 1103.21 \\ \underline{-\ 927.875} \end{array}$

3. Subtraction of Fractional Values

When we subtract fractional values, we must use the same procedure as we used in adding such values: That is we must bring the fractions to a common denominator.

EXAMPLE: Subtract $\frac{1}{8}$ from $\frac{1}{4}$

We must first bring the quantities to a common denominator, which is 8.

So $\frac{1}{4} = \frac{2}{8}$ and $\frac{2}{8} - \frac{1}{8} = \frac{1}{8}$

SELF CORRECTING EXERCISE 12

Subtract. Express answers in their lowest terms.

(a) $\frac{9}{16} - \frac{5}{16}$

(b) $\frac{7}{8} - \frac{3}{8}$

(c) $\frac{13}{16} - \frac{5}{8}$

(d) $\frac{3}{4} - \frac{3}{8}$

(e) $\frac{1}{2} - \frac{3}{16}$

(f) $\frac{3}{4} - \frac{1}{16}$

4. Subraction of Mixed Numbers

When you have mixed numbers, subtract the fractional values from the fractional values and the whole numbers from the whole numbers.

EXAMPLE:

$$\begin{array}{r} 7\frac{3}{4} \\ -\ 2\frac{1}{4} \\ \hline 5\frac{2}{4} = 5\frac{1}{2} \end{array}$$

SELF CORRECTING EXERCISE 13

Subtract. Express answers in simplest form.

(a) $\begin{array}{r} 18\frac{7}{8} \\ -\ 4\frac{3}{8} \\ \hline \end{array}$

(b) $\begin{array}{r} 91\frac{1}{2} \\ -\ 13\frac{3}{16} \\ \hline \end{array}$

(c) $\begin{array}{r} 14\frac{3}{8} \\ -\ 7\frac{1}{16} \\ \hline \end{array}$

(d) $\begin{array}{r} 29\frac{13}{16} \\ -\ 5\frac{1}{2} \\ \hline \end{array}$

Suppose that the fraction being subtracted is greater than the other fraction. In this case, we must borrow from the whole number.

Remember $1 = \frac{2}{2}$ or $\frac{4}{4}$ or $\frac{16}{16}$ or $\frac{32}{32}$

EXAMPLE: $13\frac{1}{4} = 12 + 1\frac{1}{4} = 12\frac{5}{4} = 12\frac{10}{8}$

$- \quad 7\frac{7}{8} = -\left(7 + \frac{7}{8}\right) = -7\frac{7}{8} = \begin{array}{r} -7\frac{7}{8} \\ \hline 5\frac{3}{8} \end{array}$

SELF-CORRECTING EXERCISE 14

Subtract. Express answers in simplest form.

(a) $\begin{array}{r} 19\frac{3}{4} \\ -\ 9\frac{1}{4} \\ \hline \end{array}$

(b) $\begin{array}{r} 21\frac{7}{8} \\ -\ 7\frac{7}{16} \\ \hline \end{array}$

(c) $32\frac{1}{4}$

$-\ 9\frac{1}{2}$

(d) $109\frac{3}{16}$

$-\ 62\frac{3}{8}$

(e) $41\frac{1}{2}$

$-\ 19\frac{7}{8}$

(f) $110\frac{3}{16}$

$-\ 9\frac{1}{2}$

(g) $75\frac{1}{8}$

$-\ 19\frac{1}{4}$

(h) $63\frac{3}{8}$

$-\ 13\frac{1}{2}$

Complete the following exercises and send them in for correction.

EXERCISE 1 Add the following.

(1) 3 + 6 + 9 + 12 + 153 =

(2) 376 + 1046 + 16 =

(3) 4097 + 17 + 9 + 17303 =

(4) four thousand seven hundred sixty two plus nine hundred seventy six.

(5) nine point six seven plus one hundred three decimal six zero three.

(6) $\frac{1}{8} + \frac{5}{16} =$

(7) $16\frac{5}{8} + 86\frac{1}{4} =$

(8)
$$\begin{array}{r} 108.7 \\ 42.9 \\ \underline{6.3} \end{array}$$

(9)
$$\begin{array}{r} 9.62 \\ 48.95 \\ \underline{327.09} \end{array}$$

(10)
$$\begin{array}{r} 9197.31 \\ 52.4 \\ 327.92 \\ \underline{4276} \end{array}$$

EXERCISE 2 Subtract the following.

(1) $\begin{array}{r} 427 \\ -\ \underline{406} \end{array}$

(2) $\begin{array}{r} 964 \\ -\ \underline{88} \end{array}$

(3) $\begin{array}{r} 4899 \\ -\ \underline{101} \end{array}$

(4) $\begin{array}{r} 961.38 \\ -\ \underline{41.03} \end{array}$

(5) $\begin{array}{r} 4873.071 \\ -\ \underline{96.09} \end{array}$

(6) $\begin{array}{r} 104.3 \\ -\ \underline{33.693} \end{array}$

(7) $\begin{array}{r} \frac{9}{16} \\ - \\ \underline{\frac{4}{8}} \end{array}$

(8) $\begin{array}{r} 2\frac{1}{2} \\ - \\ \underline{\frac{3}{8}} \end{array}$

(9) $\begin{array}{r} 12\ \frac{5}{6} \\ - \\ \underline{4\ \frac{2}{12}} \end{array}$

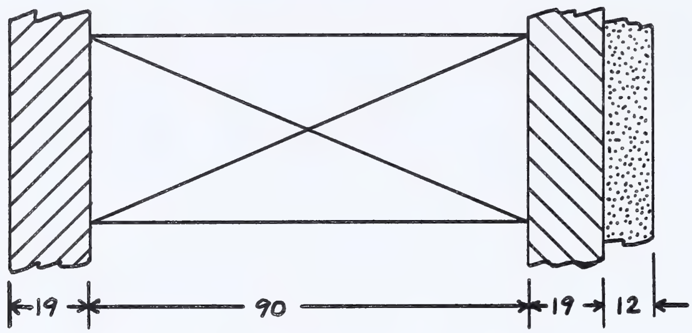
10. three and three fourths subtracted from eight and six eighths.

EXERCISE 3

Complete the following questions. All work should be shown as to how you calculated the answers. Answers must be in SI metric notation.

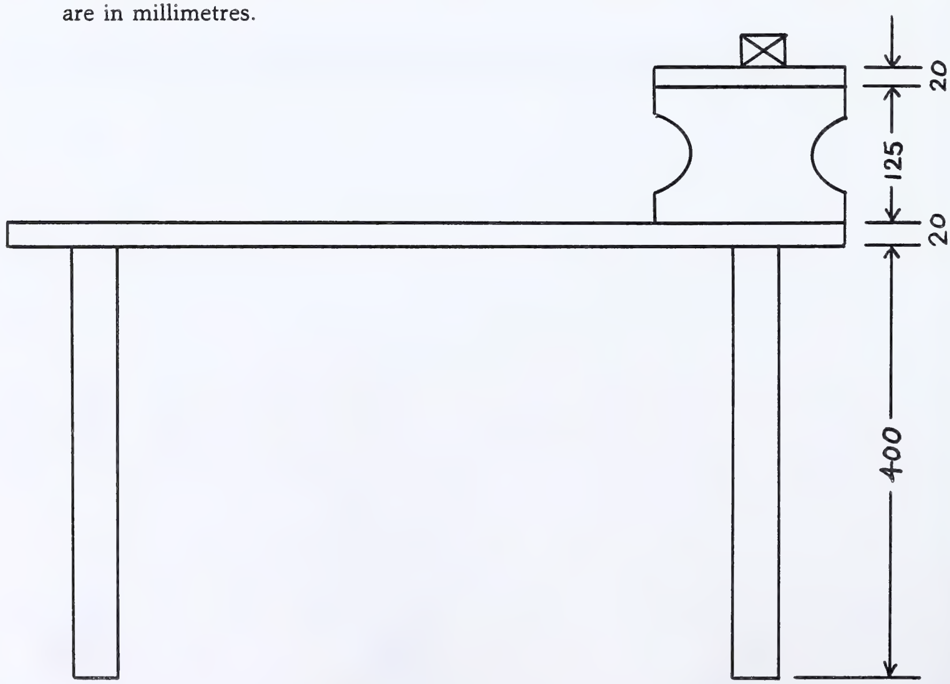
1. A wall of a house is made up of the following layers of material, starting from the inside.

   A 19 mm layer of plasterboard, a 90 mm stud, a 19 mm layer of plywood sheeting, 12 mm of stucco, as shown in the diagram below.



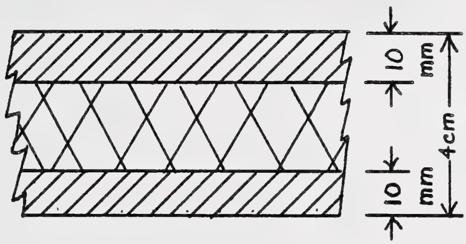
   How thick is the entire wall?

2. A telephone table is constructed as shown in the diagram below. All dimensions are in millimetres.

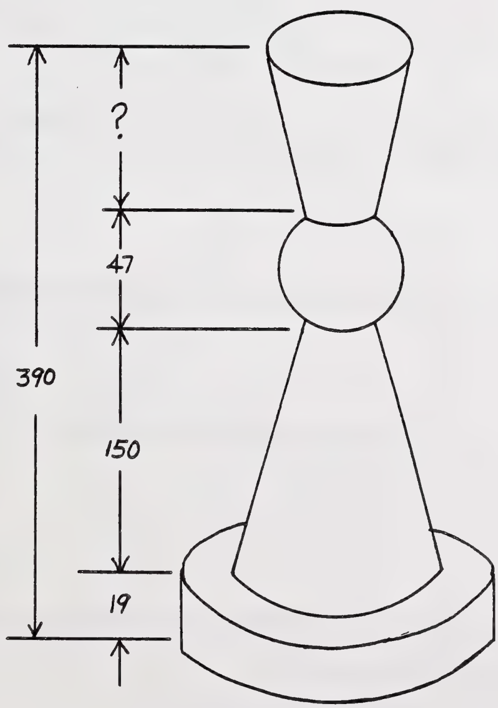


   How high is the block (☒) above the floor?

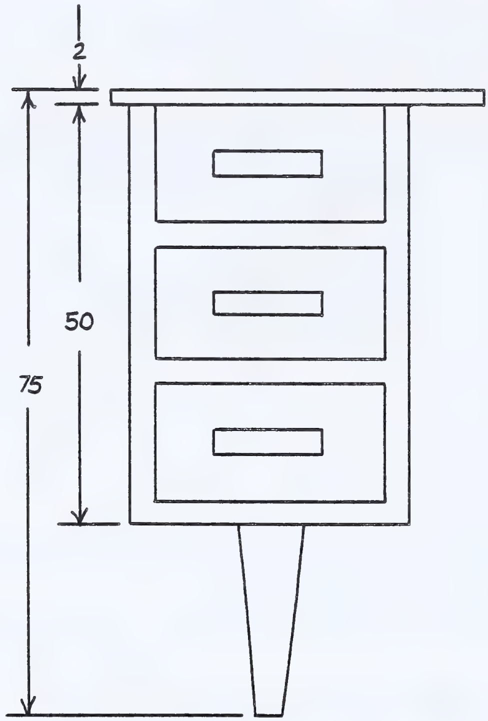
3. An insulating panel is constructed of a layer of fibreboard between two sheets of plywood, as shown in the diagram below. If the panel is 4 cm thick and each sheet of plywood is 10 mm thick, how thick is the sheet of fibreboard in the middle of the panel?



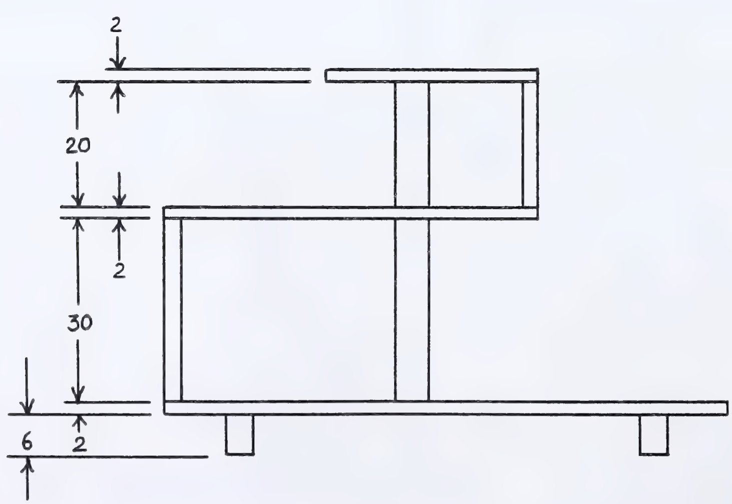
4. The base for a lamp is made of wood in the shape shown in the diagram below. From the dimensions given calculate the length of the upper conical section. All dimensions are in millimetres.



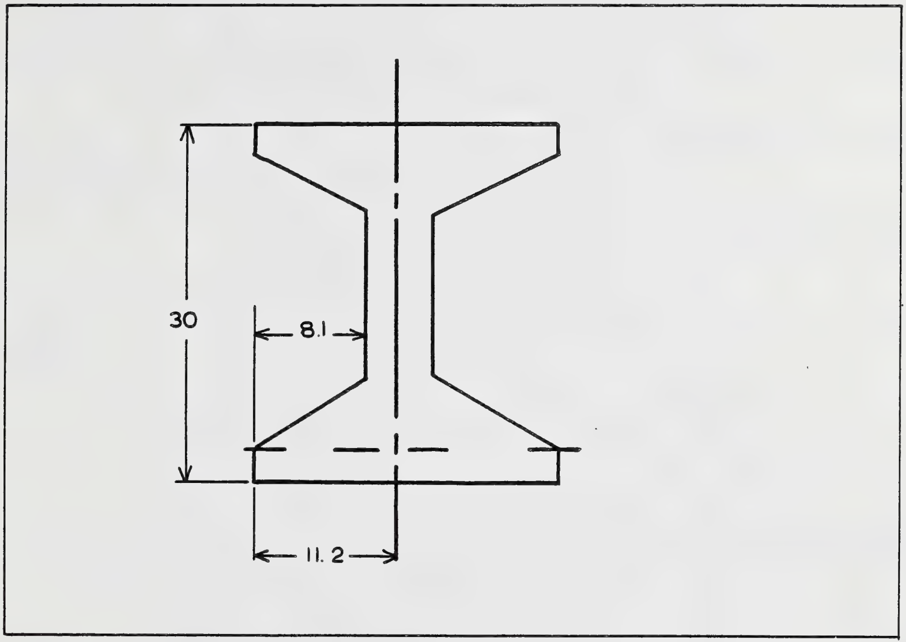
5. A desk is made with a 2 cm thick top and a series of drawers that are 50 cm high. How long must the legs be so that the top of the desk is 75 cm from the floor. A diagram is given below. Only one half of the desk is shown as the other side of the desk is similar. Dimensions are in centimetres.



6. A bookcase is made in the shape and to the dimensions given in the diagram below. How high is the bookcase? All dimensions are in centimetres.



7. (a) A steel I-beam is used to provide support for the rafters of a machine shop. A cross sectional view of the beam is indicated below. Dimensions are in centimetres. What is the thickness of the centre of the beam?
(HINT: the I-beam is symmetrical.)



(b) What is the width of the I-beam?

Answers to Self Correcting Exercises

S.C.E. 1 (a) 47, (b) 178, (c) 3891, (d) 17421, (e) 26435. (f) 11009, (g) 16 000

S.C.E. 2 (3.99) Three and ninety-nine hundredths, (60.02) Sixty and two hundredths, (391.627) Three hundred ninety one and six hundred and twenty seven thousandths, (200.202) Two hundred and two hundred and two thousandths, (191.056) One hundred and ninety one and fifty six thousandths, (100.001) One thousand and one and one one thousandths.

S.C.E. 3 (3.99) Three point nine, nine; (60.02) Sixty point zero two; (391.627) Three ninety one point six two seven; (200.202) Two hundred point two zero two; (191.056) one hundred ninety one decimal zero five six; (1001.001) One thousand one decimal zero zero one.

S.C.E. 4 1. (a) 190.1, (b) 1839.25, (c) 10 943.775
2. (a) 265.40, (b) 424.218, (c) 3112.601
3. (a) 240.26, (b) 1 211.082

S.C.E. 5 (b) $\frac{17}{100}$, (c) $\frac{169}{1000}$, (d) $\frac{591}{1000}$, (e) $\frac{1668}{1000}$, (f) $\frac{506}{1000}$

S.C.E. 6 (b) 3/8, (c) 5/16, (d) 15/16, (e) 15/16

S.C.E. 7 (a) 1 3/8, (b) 1 3/4, (c) 1 15/16, (d) 2 1/8, (e) 1 1/4, (f) 1 1/2, (g) 1 1/2, (h) 1 7/8

S.C.E. 8 (a) 7/8, (c) 22 1/2, (d) 24 1/4, (f) 7 1/8, (g) 41 1/8, (h) 27 15/16

S.C.E. 9 (a) 1238, (b) 801, (c) 2131, (d) 144

S.C.E. 10 (a) 653.3, (b) 181.14, (c) 15.361, (d) 9.910, (e) 136.209, (f) 438.258

S.C.E. 11 (a) 3.94, (b) 37.17, (c) 64.829, (d) 175.335

S.C.E. 12 (a) 1/4, (b) 1/2, (c) 3/16, (d) 3/8, (e) 5/16, (f) 11/16

S.C.E. 13 (a) 14 1/2, (b) 78 5/16, (c) 7 5/16, (d) 24 5/16

S.C.E. 14 (a) 10 1/2, (b) 14 7/16 (c) 22 3/4, (d) 46 13/16, (e) 21 5/8, (f) 100 11/16 (g) 55 7/8, (h) 49 7/8

END OF LESSON 11

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY	
Date Lesson Submitted ______	(If label is missing or incorrect)
Time Spent on Lesson ______	File Number ______
	Lesson Number ______

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Assigned Teacher: ______

Lesson Grading: ______

Additional Grading E/R/P Code: ______

Mark: ______

Graded by: ______

Assignment Code: ______

Date Lesson Received: ______

Lesson Recorded ______

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1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

WOOD PRODUCTS

Wood structure and lumber
Plywood and related wood products
Formed wood products

INTRODUCTION

Wood is of great historical importance to man. It has been used as a fuel, a building material, for weapons, and for transportation. Man is still making use of wood for these purposes after many centuries and has added considerably to these uses, both indirectly and directly.

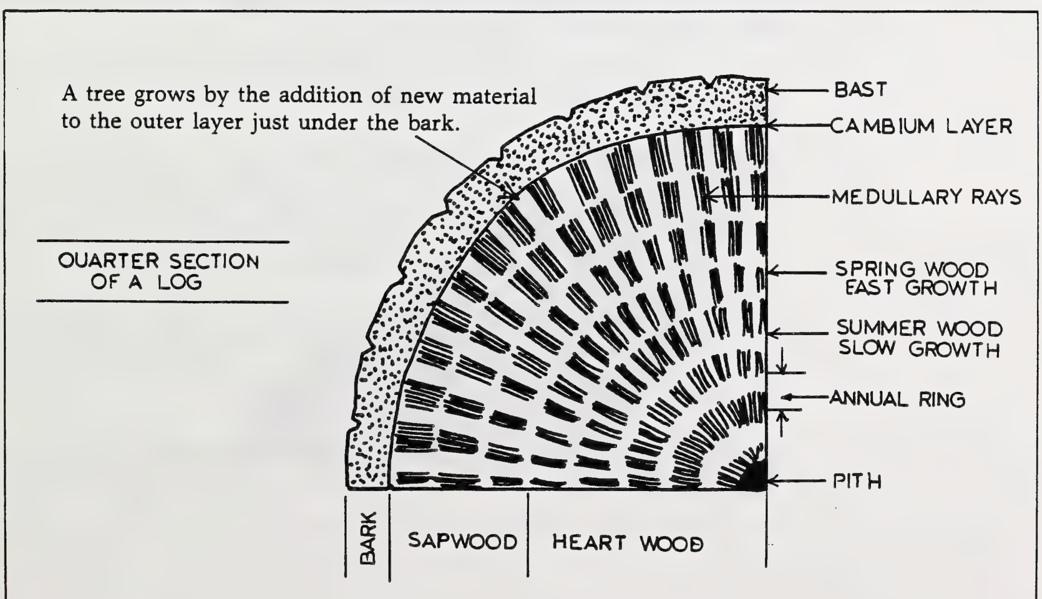
Wood is easily worked and has beauty and durability (does not rust or corrode) and, if properly cured and placed, will not rot. It has a great ability to absorb shocks and sound, can be flexed repeatedly without weakening (steel will crack or break if flexed too many times), and has reasonable insulation value. It is comparatively light in weight and is adaptable to a large number of uses.

One of the most important things we must remember about wood is that it is renewable. Many building products, once used, are gone. Steel, cement, etc. will not grow back to be harvested again. Trees can be planted, grown, and harvested and this cycle repeated forever (reforestation). Some lumber suppliers have even started their own 'tree farms'. The list of products made directly or indirectly from trees is phenomenal. Saw mills, speciality mills, plywood mills, and pulp mills provide the most obvious products but when we include wood distillation plants and wood hydrolysis plants the list grows considerably.

WOOD STRUCTURE AND LUMBER

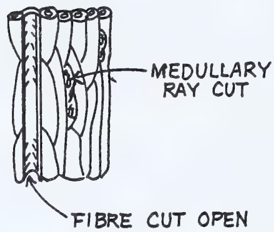
1. Wood Structure

Wood is valuable as a building product because of the manner in which a tree grows, forming bundles of long fibers lengthwise in the tree.



Look at the cross section of a tree as shown on page 1. You can see that the tree trunk consists of a series of concentric rings (annual rings) covered by the bark. These run the full length of the tree from bottom to top, like a series of long tubes fitting tight one inside the next, and so on. These annual rings are composed of two layers. The inner lay is the softer, lighter colored springwood which resulted from a short and fast growth. The outer layer is the harder, darker summerwood which resulted from a longer but slower growth period. This distinction is exceptionally clear in Douglas Fir and much less clear in Poplar.

The growth takes place just under the bark in the cambium layer. The cells which form there are long, thin, tubular fibers (see diagram to the left), composed mainly of cellulose, bound together by lignin. These bundles of fibers run the entire length of the tree because they carry raw materials from the roots to the branches and to the leaves. The medullary rays run inward at right angles to these vertical fibers to carry materials from the inner bark, or bast to the cambium layer and they also store food. They are much more obvious in some woods, such as oak, but are present in all trees.



The heartwood, which is nearer to the center of the tree, is composed of older, dead layers of cells which no longer function as food storage cells. It is usually darker, harder, and drier than the sapwood and lends stiffness to the tree. The sapwood is the living layer of cells, is closer to the outside of the tree, and is usually lighter in color.

2. Classification

Lumber can be divided into several classifications. The two we will discuss are hardness and grain. These topics concern the cabinet making section of building construction much more than the general construction (framing) area of building construction. The framer may be concerned with strength (related to hardness) but will not generally be interested in the grain appearance of the wood.

(a) Trees are generally divided into two groups, hardwoods and softwoods. Described below are two systems of classifying them.

(i) One system of grouping hardwoods uses the fact that most deciduous trees (trees with leaves which drop in the fall) produce hardwoods and most coniferous trees (trees with needles) produce softwoods. There are exceptions to these guidelines. For example, poplar is relatively soft whereas trees classified as softwoods (such as douglas fir) are much harder.

(ii) Another system involves the use of density. This gives a better comparitive classification. Density is the mass per unit volume and it is usually recorded in kg (mass) per m^3 (volume). For example, white oak has a density of 753 kg/m^3 and western red cedar about 368 kg/m^3.

The following list indicates a few woods with their densities in kg/m^3 (the denser the wood the harder it is). (H) indicates a hardwood, (S) indicates a softwood.

White Oak	753 (H)	American Elm	561 (H)
Red Oak	705 (H)	Douglas Fir	529 (S)
American Beech	721 (H)	Bald Cypress	512 (S)
Rock Elm	705 (H)	Yellow Poplar	481 (H)
Sugar Maple	705 (H)	Sitka Spruce	449 (S)
True Hickory	673- 833 (H)	Ponderosa Pine	449 (S)
White Ash	673 (H)	White Fir	432 (S)
Western Hemlock	625 (S)	Western White Pine	432 (S)
Western Larch	609 (S)	Quaking Aspen (White Poplar)	416 (H)
Black Walnut	609 (H)	Sugar Pine	400 (S)
Shortleaf Pine	577 (S)	Englemann Spruce	384 (S)
Sweet Gum	577 (H)	Cottonwood (Black Poplar)	416 (H)
Black Cherry	561 (H)	Western Red Cedar	368 (S)

As you can see hardwoods generally are at the top of the density scale while the largest percentage of softwoods are at the lighter end of the scale, but note the exceptions. Hardwoods, such as birch, maple, and walnut are usually about 10 times the price of softwoods.

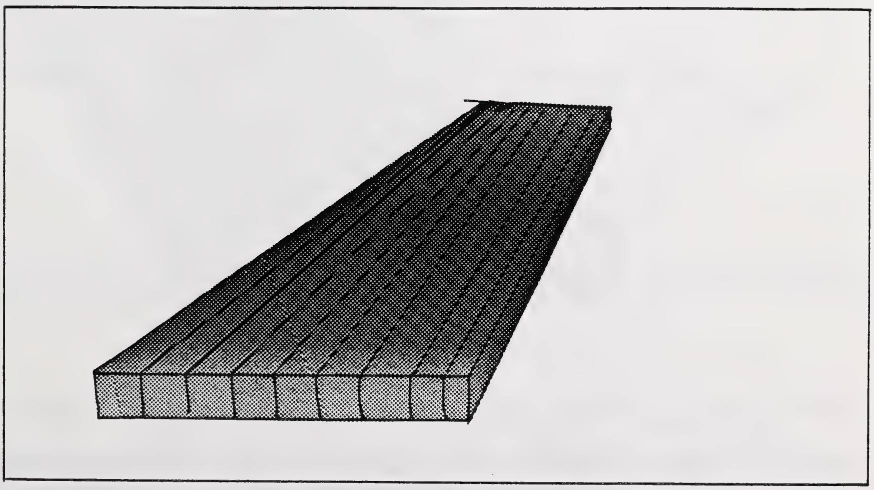
(b) Trees (or wood) are also divided into open and closed grain. This refers to the visibility of the sap carrying pores of a tree. The openness of the grain varies from one type of wood to another.

(i) Most softwoods plus poplar (a hardwood) are closed-grained woods because the fiber bundles are packed together so closely that there are no pores visible on the surface of a board. These closed-grained woods do not require fillers prior to the finish coats of varnish (a sealer such as a coat of shellac may be desirable to close off the small pores).

(ii) Oak and mahogany are called open-grained woods because the pores are readily visible. The surface of open grained woods must have fillers rubbed into the surface to seal off these large open pores if a smooth finish is desired.

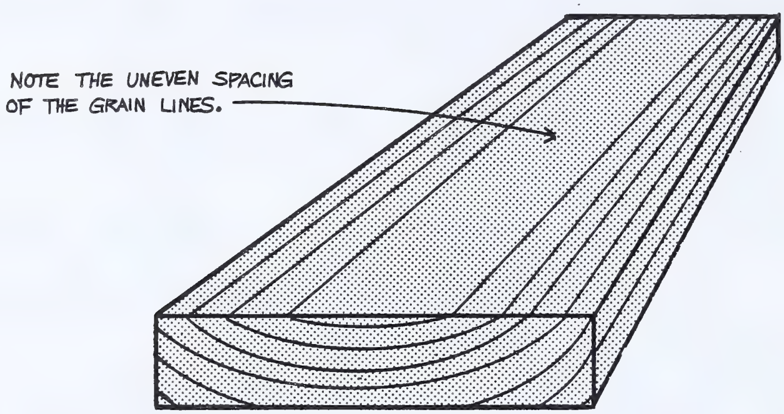
(c) Lumber can be classified according to the way it was cut from the tree. Edge grain, flat grain, and angle grain refer to the manner in which a log is sawn at the mill.

(i) If a log is cut so that the annual rings run at 90° (right angles) to the wide surface of the board it is called edge grain or quarter sawed lumber.

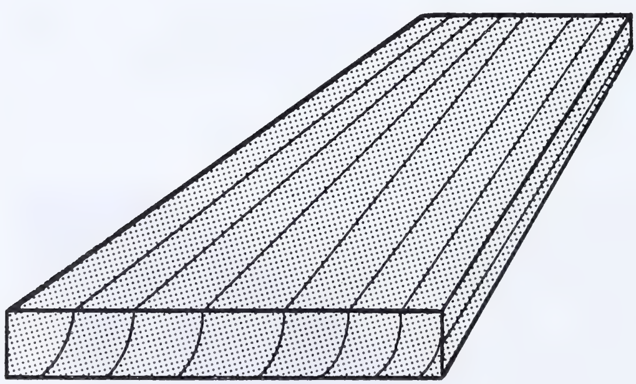


Edge grain lumber is used when a board is going to be subject to wear (such as for flooring and for door sills) and where resistance to warpage is necessary (window sills and trim).

(ii) When the annual rings run more or less parallel to the surface of a board, the lumber is said to have a flat grain which is not as durable or strong as edge grain and is subject more to warping.



(iii) Angle grain is about half way between edge grain and flat grain. Angle grain lumber has the annual rings running across the end of the board at approximately 45°.



(c) Lumber can also be classified according to the spacing of the grain lines. A fast growing tree would tend to produce a coarse grained lumber whereas a slow growing tree would produce an even grained lumber.

(i) Even grained lumber has closely spaced, regular grain lines.

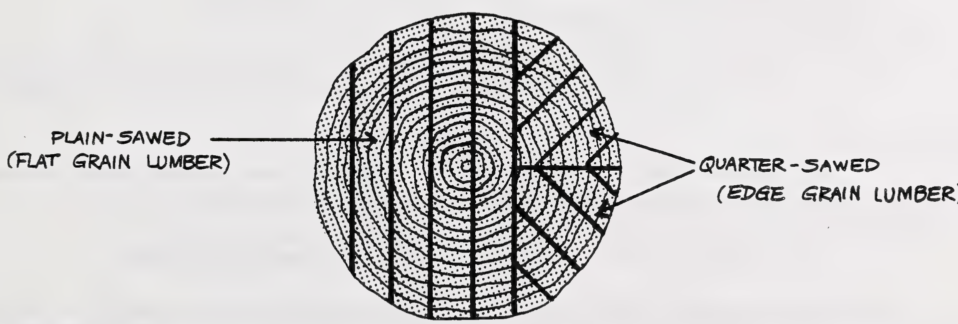
Even grain as seen from the end of the board.

(ii) Coarse grained lumber has grain lines quite far apart and varying. The texture of the board is rather coarse and rough.

Coarse grain as seen from the end of the board.

3. Sawing Lumber

The position of the board in the log and the direction the saw cuts across the log determines whether we get edge grained, angle grained, or flat grained lumber. Below is a diagram which illustrates how a tree can be sawn.



Keep in mind that the type of grain you have is much more important in cabinet work than in general construction.

4. Wood Defects

Fungi are considered to be the chief enemy of wood. They are low forms of plant growth which use various chemical compounds of wood as food. Three common diseases caused by fungi are mold, wood rot, and sap stain. At first fungi discolor the wood but, after a period of time, they also reduce the strength of lumber. If wood is fully seasoned, the fungi will no longer be active. Brown rot and white rot are caused by fungi which detroy the cellulose (brown, soft residue left) or the lignin (soft, white residue left).

Incipient decay is the term used to describe the early growth (mostly surface) of fungi and advanced decay is the term used to describe later stages (rot) of fungi growth.

For fungi to develop certain conditions are required:

(a) There has to be a suitable food source present. In lumber this is green lumber (lumber which is not properly dried) or damp lumber.

(b) 'Dead' or stale air is required. If no air is present as (in buried logs), fungi will not grow. If lots of air circulation is present, the area will dry out and no fungi growth will occur.

(c) Moisture has to be present. This is the reason why you may have noticed that the most common place to find rotted lumber is at ground level and just below ground level (where there is still slight air circulation).

(d) The temperature has to be in the correct range. If the temperature is very warm or quite cold, lumber does not rot.

Some people seem to set up a perfect 'rot heaven' as they construct a building.

First they pour a concrete footing, or set up blocks (for a building such as a lake cottage), at ground level. Next they put the floor joints directly on the top of the blocks so that the joists are 0-25 cm from the topsoil and finish their building on top of this floor frame. Their third step is to seal off the space under the building 'so that the floor won't be cold', and leave no screened vents for air circulation. After about one month, take off one of the boards which are nailed around the building just above ground level and look under the joists. You will probably see pretty, fuzzy green and black spots about the size of a dime all over the joists with a few large brownish or white spots developing. As well there is usually a pleasant, sweet smell occurring.

The following points list ways rot can be prevented.

(a) Use properly seasoned lumber (low moisture content).

(b) If possible, make sure the surrounding air is warm and dry (like a basement). If not, make sure the area is well-vented (such as under a cottage or granary) to clear out stale air.

(c) Use creosoted lumber or brush on a generous coat of wood preservative such as Pentox, Barrot, etc. (which contain pentachloriphenol).

Drying (or curing) of lumber is carried out in one of two ways:

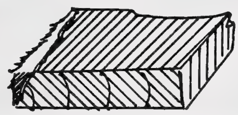
(a) Air-drying is the most common method for drying most lumber used in general construction. Lumber should be strip-piled at a slope on a solid foundation. Strip-piling allows air to circulate all around each piece of lumber and the slope allows for run-off of rain and melted snow. By this method, the moisture content of lumber can be reduced to about 15%. This is a relatively slow but inexpensive method which is mainly used for framing lumber.

(b) Kiln Drying (KD) is a faster, and more expensive, method of drying lumber. Both temperature and humidity are controlled and the moisture content (MC) can be reduced 5-10% which is necessary for furniture and general interior use. The process starts with the humidity high and the temperature low. Humidity is reduced and heat increased, gradually, until the lumber reaches the 5-10% MC required.

Included with wood defects are the following items. (Remember if they affect both appearance and strength they are a defect whereas if they affect appearance only they are considered a blemish.)

(a) Knots are not necessarily injurious to either strength or appearance unless there are too many or they are loose.

(b) Wanes are pieces of bark along a corner of a piece of lumber.

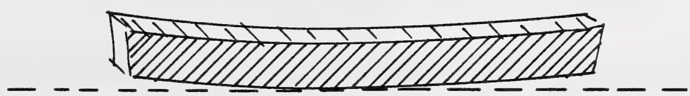


(c) Pitch pocket - a hollow or depression (filled with pitch) in a piece of lumber.

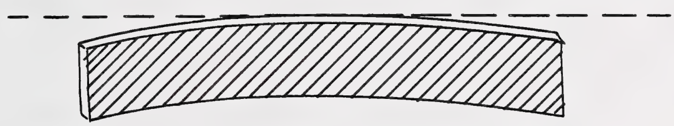
(d) Stain streaks are discolorations caused by seasoning or slight decay (more of a blemish than a defect).

(e) Warp is a distortion of the flat surface of a board:

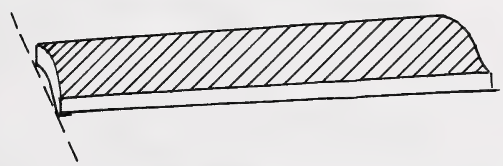
(i) Crook



(ii) Bow

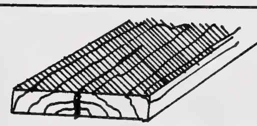


(iii) Cup

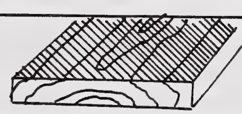


(f) Worm Holes are small holes caused by wood borers. Although they usually affect only appearance in Canada, they can also affect strength if there are many worm holes in a board.

(g) Checks are lengthwise separations in the wood, across the annual rings.



(h) Shakes are also lengthwise separations in the wood but occur along the annual rings.



All of the above eight affect appearance and/or strengh and, therefore, grading of lumber.

5. Grading and Sizing Lumber

These grades apply mainly to domestic softwoods commonly used for building construction. Imported lumbers and domestic hardwoods are graded differently.

(a) There are eight categories of lumber, and each category denotes what use the lumber will be put to. The chart below shows the various categories and their related uses.

<table>
<tr><th>GENERAL CATEGORY</th><th>Nominal Rough Size</th><th>Principal Use</th><th>Grades</th></tr>
<tr><td>LIGHT FRAMING</td><td>50 mm to 100 mm thick
up to 100 mm wide</td><td>General construction uses such as rafters, studs, and small joists</td><td>Construction Grade
Standard Grade
Utility Grade
Economy Grade</td></tr>
<tr><td>STUD</td><td>50 mm to 100 mm thick
up to 150 mm wide
up to 3 m long</td><td>Studs for interior or exterior walls.</td><td>Stud</td></tr>
<tr><td>STRUCTURAL LIGHT FRAMING</td><td>50 mm to 100 mm thick
up to 100 mm</td><td>Trussed rafters and engineering uses wide</td><td rowspan="2">Select Structural Grade
No. 1 Grade
No. 2 Grade
No. 3 Grade</td></tr>
<tr><td>STRUCTURAL JOIST AND PLANK</td><td>50 mm to 100 mm thick
125 mm wide and wider</td><td>General construction where heavier stresses are encountered, such as floor joists, planks, etc.</td></tr>
<tr><td>APPEARANCE</td><td>50 mm to 100 mm thick
50 mm wide and wider</td><td>Exposed lumber where looks as well as strength are important.</td><td>Appearance Grade</td></tr>
<tr><td>WALL AND ROOF PLANK</td><td>50 mm to 100 mm thick
150 mm wide and wider</td><td>Roof and floor decking such as large porches</td><td>Select-decking
Commercial decking</td></tr>
<tr><td>BEAMS AND STRINGERS</td><td>125 mm and thicker. Width more than 50 mm greater than thickness</td><td>Heavy Beams for horizontal support. They are rectangular cross section.</td><td rowspan="2">Select Structural
No. 1 Structural
(also standard & utility)</td></tr>
<tr><td>POSTS AND TIMBERS</td><td>125 mm by 125 mm larger</td><td>Usually square columns used for posts and supports for roots etc.</td></tr>
</table>

It should be noted that the above chart is for dimension lumber which is for framing members such as joints, planks, rafters, studs, and small timbers. It does not apply to those grades that are cut for special use (such as flooring or panelling).

(b) Table 1 Canadian Softwoods

Strength Group CSA 086 (1)(4)	Species Commercial Designation	Species in Combination (3)	Wood Characteristics
Group A	Douglas fir-Larch	Douglas Fir (Pseudotsuga menziesii) Western larch (Larix occidentalis)	Woods similar in strength and weight. High degree of hardness and good resistance to decay. Good nail holding, gluing, and painting qualities. Color ranges from reddish-brown to yellowish-white.
Group B	Hem-fir	Western hemlock (Tsuga hetrophylla) Amabilis fir (Abies amabilis) Grand fir (Abies grandise)	Light woods of moderate strength. They work easily, take paint well and hold nails well. Good gluing characteristics. Color range pale yellow-brown to white.
Group C	Eastern hemlock-Tamarck	Eastern hemlock (Tsuga canadensis) Tamarack (Larix laricina)	Moderately strong woods mostly used for general construction. Fairly hard and durable. Color range yellowish-brown to whitish.
Group D	Coast sitka spruce	Coast sitka spruce (Picea sitchensis)	A light, resilient wood of moderate strength that works and takes paint easily and holds nails well. Creamy white to light pink in color with large proportion of clear wood.
	Ponderosa pine	Ponderosa pine (Pinus ponderosa)	Moderately strong and easily worked to smooth uniform texture. Takes paints, stains and varnishes well. Seasons readily. Good nail holding qualities. Color variable from pale yellow sapwood to deep yellow to reddish-brown heartwood. Considerable figure in heartwood.
	Spruce-Pine-Fir	White spruce (Picea glauca) Red Spruce (Picea rubens) Black spruce (Picea mariana) Engelmann spruce (Picea engelmannii) Lodgepole pine (Pinus contorta) Jack pine (2) (Pinus banksiana) Alpine fir (Abies lasiocarpa) Balsam fir (Abies balsamea)	Woods of similar characteristics, they have moderate strength, work easily, take paint easily and hold nails well. Generally white to pale yellow in color.
Group E	Eastern white pine	Eastern white pine (Pinus strobus)	Softest of the Canadian pines, it works and finishes exceptionally well. Not as strong as most pines but does not tend to split or splinter. Good nail holding properties. Low shrinkage, better than all other Canadian species except the cedars. Takes stains, paints and varnishes well. Color of sapwood almost white, heartwood creamy white light straw brown.
	Red Pine	Red pine (Pinuse resinosa)	A fairly strong and easy to work wood that takes a good finish and holds nails and screws well. Moderately durable: it seasons with little checking or cupping. Sapwood is thick, pale yellow color, heartwood pale brown to reddish tinge.)
	Western cedars	Western red cedar (Thuja plicata) Pacific coast yellow cedar (2) (Chamaecyparis nootkatensis)	Woods of disparate strength but similar exceptional resistance to decay. High in appearance qualities, they both work easily and take fine finishes. Each species has distinct and easily recognizable coloration; red cedar varies from reddish-brown heartwood to light sapwood, and yellow cedar has a uniform yellow color.
	Western white pine	Western white pine (Pinus monticola)	Characteristics of the wood are very similar to those of Eastern white pine.

(1) Group A woods are strongest. Group E woods are weakest.
(2) When two or more species of different strength groups (CSA 086) such as Western red cedar (Group E) and Pacific coast yellow cedar (Group C) are combined commercially, span tables are based upon design values for the weakest species in the group.
(3) Sometimes individual species within commercial groups are identified and marked separately.
(4) Not shown are Group F woods which include those Poplars, Trembling aspen, Largetooth aspen, Balsam poplar.

(c) Grade Marks

Most lumber used for framing purposes is stamped with a grade mark. Specialty items, such as lumber to be remanufactured for millwork, or lumber manufactured for decorative purposes, are seldom marked.

Each grade mark or stamp used in Canada contains the initials of the name of the regional association responsible for grading. The names of these associations are shown opposite the facsimile stamps.

In addition, stamps indicate the grade of the piece of lumber, often by means of an abbreviation. Examples of such abbreviations include:

Const -- Construction Grade
Stand -- Standard Grade
Util -- Utility Grade
Stud -- Stud Grade
Sel Str -- Select Structural Grade.

The species is indicated on the stamp by means of the species name or abbreviation. Abbreviations used include:

Abbreviation	Species Commercial Designation
C Sit Spr	Coast sitka spruce
D Fir-L	Douglas fir-larch
East White Pine	Eastern white pine
Hem-Tam	Eastern hemlock-Tamarack
P Pine	Ponderosa pine
S-P-F	Spruce-Pine-Fir
W Cedar	Western cedars
W W Pine	Western white pine
Abbreviation	**Individual Species**
D Fir	Douglas fir
W Hem	Pacific coast hemlock
W W Spr	Western white spruce

A number of Canadian species are grown, harvested, manufactured and marketed together and have similar properties which make them interchangeable in use. Because some species cannot be separated visually in lumber form, these are given a common name on the grade stamp. Combinations of species which are commonly manufactured and identified by such a single commercial species name are indicated in Table I.

Facsimiles of typical grade marks of lumber associations and grading agencies certified by the Canadian Lumber Standards Administrative Board to grade mark lumber in Canada are shown in the following pages. Although the basic design varies between agencies, each grade mark shows the name (or symbol or both) of the grading agency; the number (or name or both) of the mill; the species designation; the grade; and either S-GRN (for surfaced green), S-DRY (for surfaced dry), or MC 15 (for lumber specially dried to 15% or less moisture content).

Below are a number of grade marks. Below each grade mark is the name of the lumber manufacturers association which uses them.

A.F.P.A.® 00
S—P—F
S-DRY STAND

Alberta Forest Products Association
204 - 11710 - Kingsway Ave, Edmonton
Alberta T5G OX5

CL®A
S-P-F
100
No. 2
S-GRN.

Canadian Lumbermen's Association
27 Goulburn Avenue, Ottawa Ontario K1N 8C7

PLIB® NLGA RULE
No 1
S-GRN
00 HEM-FIR-N

Pacific Lumber Inspection Bureau
Ste. 1130, 1411 Fourth Avenue Building
Seattle, Washington 98101
B.C. Division: 1460 - 1055 West Hastings Street
Vancouver B.C. V6E 2G8

CLMA® 1 S-GRN 1
1 D FIR (N)

Cariboo Lumber Manufacturers Association
301-197 2nd Avenue North, Williams Lake, B.C.
V2G 1Z5

COFI® S-P-F
S-GRN
100 No 1

Council of the Forest Industries of British Columbia
1500-1055 West Hastings Street, Vancouver 1, B.C.

Commercial Species or Species Group Designation	Abbreviation Permitted on Grade Stamps	Species included in Group	Stress Group** in Canadian CSA 086
Douglas fir-Larch (North*)	D Fir-L	Douglas fir, Western larch	A
Hem-Fir (North*)	Hem-Fir	Western hemlock, Amabilis fir, Grand fir (in Canada only)	B
Eastern hemlock-Tamarack	Hem-Tam	Eastern hamlock, Tamarack	
Pacific coast yellow cedar	Y Cedar	Pacific coast yellow cedar	C
Jack pine	--	Jack pine	
Spruce-Pine-Fir	S-P-F	White spruce, Englelmann spruce, Black spruce, Red spruce, Lodgepole pine, Jack pine, Alpine fir, Balsam fir	
Coast sitka spruce	C Sit Spr	Sitka spruce	D
Ponderosa pine	P Pine	Ponderosa pine	
Red pine	--	Red pine	
Western white pine	W W Pine	Western (Idaho) white pine	
Eastern white pine (North*)	East White Pine	Eastern white pine	E
Western cedars (North*)	W Cedar	Western red cedar, Pacific coast yellow cedar	

*When used on grade stamps, designation 'North' provides regional identification for export to U.S. **Poplars are Group F

There is quite a difference in the various grades. Beams made of No. 1, A Douglas fir could span a distance of 6.45 m. The same beam out of No. 3, E Red pine could only span a distance of 4 m, almost 2.5 m less! For houses, CMHC publishes a book of charts on the amount of force each stress group can take when spanning an opening. If one type of lumber is too weak, a carpenter has two choices. One is to choose a stronger lumber by choosing boards from a high stress group (i.e. Group B is stronger than Group C). The other choice is to use a larger board (i.e. use 38 mm × 300 mm board instead of 38 mm × 250 mm board).

(c) Common Metric Sizes

Below is a chart which lists the common sizes of domestically cut framing lumber.

Standard Thicknesses (millimetres)	Widths (millimetres)
19	38,63,89,114,140,184,235,286
25	38,63,89,114,140,184,235,286
32	38,63,89,114,140,184,235,286
38	38,63,89,114,140,184,235,286
63	63,89,114,140,184,235,286
89	89,114,140,184,235,286

Standard lengths of lumber are 2.4. 3.0, 3.6, 4.2, 4.8, 5.4, and 6 metres.

6. How to Order and Price Lumber

(a) Ordering

Lumber is ordered in this exact way:

No. of pieces - thickness × width - length

thickness: mm, width: mm, length: m

Units used when ordering lumber.

Example:

50 - 19mm × 100 mm - 6.0 m

(b) Pricing

In the new SI system bulk quantities of lumber will be measured and priced in units of cubic metres rather than the customary board feet. This means that lumber is priced by VOLUME not by length or area. So in order to find the price of a certain amount of lumber you have to calculate its volume. Here is how you do it.

Step 1 Convert all dimensions to metres.

Step 2 Multiply No. of pieces × thickness in metres × width in metres × length in metres to get the total number of cubic metres.

Step 3 Multiply the number of cubic metres times the price per cubic metre.

Below is an example so you can see how this works.

Let us say a certain wood costs $\$75/m^3$ and we have

50 - 19 mm × 100 mm - 6.0 m

Step 1 In metres this is $\frac{19\text{ m}}{1000} \times \frac{100\text{ m}}{1000} \times 6.0\text{ m}$

Step 2 $= 50 \times 0.019\text{ m} \times 0.1\text{ m} \times 6.0\text{ m} = 0.57\text{ m}^3$

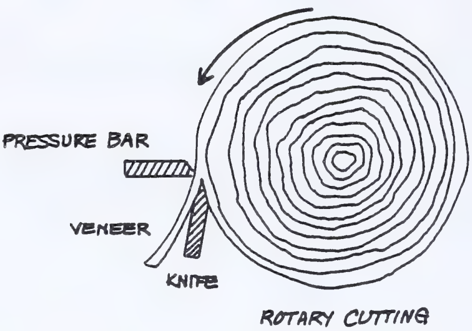
Step 3 $0.57\text{ m}^3 \times \$75/\text{m}^3 = \$42.75$

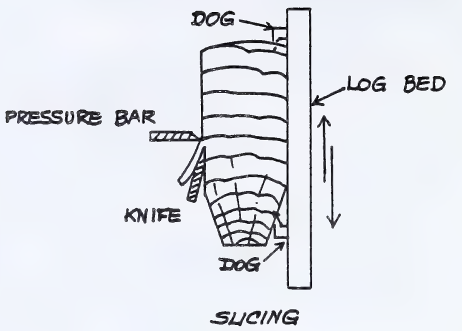
PLYWOOD AND RELATED WOOD PRODUCTS

Lumber happens to be the most common wood product but its uses are dwindling as related wood products replace lumber more and more.

1. Plywood

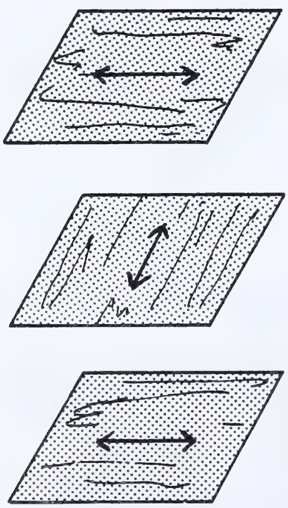
Most plywoods are built from a series of layers of wood called veneers. These layers of veneer are made in various ways. On page 14 are diagrams showing two of the many methods used for manufacturing veneer.

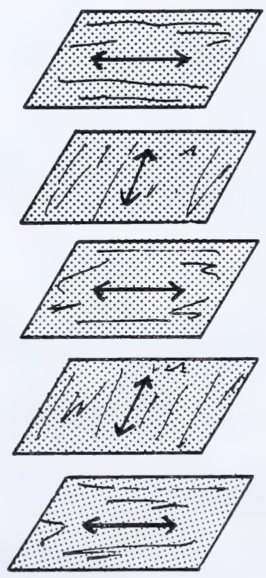




Once these layers of veneer are cut from a log, they are dried. If the veneer is to be used on the outer surface of good plywood, the knot holes are patched on a patching machine.

When the layers of veneer are built up into a sheet of plywood, the grain in the outer veneers (faces) runs lengthwise with the sheet. If there are only three layers, the center veneer (core) will run crossways as shown below on the left. If there are more than three layers, the outside two are faces, the centre layers are the core, and the pieces between the face and the core are the crossbands (as shown below right).



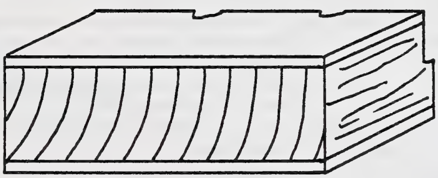


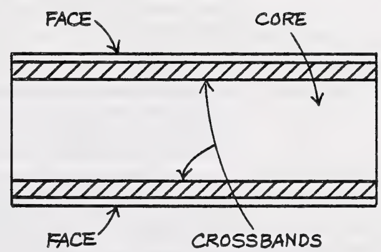
Because of this type of construction, plywood has great resistance to splitting even close to the edge of the panel. It also has greater nail-holding power than boards (6.4 mm plywood has approximately equal nail holding power to a 19 mm board). Movement in plywood due to swelling and shrinking (gain and loss of moisture) is almost neutralized because of the opposite grain direction in layers.

The layers are glued together with phenolic resin glue. This makes the plywood panel waterproof and hence suitable for exterior use.

Plywood can be bent more easily than solid wood of the same thickness. The amount that a sheet can be bent depends on its thickness. When plywood is made of waterproof glue, its ability to bend can be increased by soaking or steaming.

Some hardwood plywoods are made of two face veneers, two crossboards, but only one thick core (called lumber core plywood) instead of veneer core.





The following are important points to remember concerning plywood.

(a) The standard width and length of plywood sheets is 1200 mm by 2400 mm. Special order sizes are available in some of the grades up to 3050 mm (or longer) by 1500 mm. Selection, however, may be limited and the price will be more than for standard sizes.

(b) Position and nail sheathing and subfloor plywoods with their surface grain running at right angles to the joists, studs, or rafters.

(c) Tongue and groove (T & G) plywood is usually used for subfloors as it eliminates a great deal of time and material. No blocking is required between the joists to support the plywood edges at each joint.

(d) With proper nailing procedures and because of the way it is constructed, plywood adds a great deal of bracing strength to floors, walls, and roofs.

WATERPROOF GLUE

FIR PLYWOOD

GRADES AND USES

GRADE	DESCRIPTION	USES
Good Two Sides (G 2 S)	Each face smooth and sound, no knots or open defects, may contain neatly made patches, suitable for highest grade paint or other finish. Waterproof glue.	Where appearance is the prime consideration, with both sides of panel exposed to view, e.g., furniture, both partitions, cabinet doors, etc.
Good/Solid (G/Solid)	Face smooth and sound, no knots or open defects, may contain neatly made patches. Back a firm solid paintable surface with neatly made patches and small sound knots. Waterproof glue.	Where best appearing surface is required on one side with relatively good appearance on the other, e.g., doors, furniture, built-in fitments, kitchen cabinets, toys, etc.
Good One Side (G 1 S)	Face smooth and sound, no knots or open defects, may contain neatly made patches. Back may have limited size knot holes or other defects which have no material effect on strength or serviceability. Waterproof glue.	Where good appearance of one side ony is a primary consideration, e.g., panelling, soffits, sliding doors, etc.
Solid Two Sides (Solid 2 S)	Each face solid, contains neatly made patches and small sound knots. Similar to back of G/Solid grade. Waterproof glue.	Same uses as Good Two Sides when finishing requirements are not as exacting, e.g., shelving, concrete forms. Recommended for opaque paint finishes.
Solid One Side (Solid 1 S)	Face solid, contains neatly made patches and small sound knots. Back may contain limited size knot holes and other defects which have not material effect on strength or serviceability. Waterproof glue.	Same uses as Good One Side when finishing requirements are not as exacting, e.g., floor underlay where sanded surface is desired. Suitable for concrete forms.
Marine	Both faces smooth and sound, no knots or open defects, may contain neatly made patches. All interior plies solid, with neatly made patches and small sound knots. Waterproof glue.	Hull planking and all marine uses.
Concrete Form 2 sides	Each face solid, contains neatly made patches, tight splits, small sound knots with reasonable amounts of rough or torn grain. Both faces sanded, edges sealed with green-coloured compound. Waterproof glue.	For concrete forms where a good, smooth surface is required and both plywood faces will be used for repetitive work.
Concrete Form 1 side	Face solid, contains nearly made patches, tight splits, small sound knots, reasonable amount of rough or torn grain. Back may contain limited size knot holes and other defects which have no material effect on strength or serviceability. Both faces sanded, edges sealed with green-coloured compound. Waterproof glue.	For concrete forms where a good, smooth surface is required and only one plywood face will be used for repetitive work.
Sheathing	Each face may have limited size open defects which have no material effect on strength or serviceability. For construction use. Waterproof glue.	Where strength and economy are required but smooth finish unnecessary, e.g., structural applications, such as roofing, wall sheathing, subflooring and single finish for farm structures, fences, utility and industrial buildings.
Select Sheathing	One face has no open defects except for limited number of splits, otherwise similar to sheathing grade.	For uses where sanded material is not required. e.g., fences and for underlay with tile, linoleum or other flooring which does not require a sanded underlay.
High Density Overlay	Resin-impregnated cellulose fibre sheet is bonded to plywood surface. Overlay is translucent, hard and smooth. Further finishing not required. Band between overlay and plywood is equal to waterproof glue line between veneers.	Excellent where hard finish is required, e.g., table tops, school furniture lockers, bins, containers, tanks, signs, fixtures, boats and displays. Ideal for concrete forms.
Medium Density Overlay	Resin-impregnated cellulose fibre overlay sheet is basically opaque although underlying grain may appear. Hard, smooth, suitable for painting. Band between overlay and plywood is equal to waterproof glue line between veneers.	Used for siding, soffits, panelling, built-in-fitments, cabinets or any use requiring superior paint surfaces.

2. Particle Board

Particle board is made from planer shavings, wood chips, and logs. Dryers remove excess moisture, then resins and binders are mixed with the wood chips. By now the wood chips are broken down into sawdust sized particles. Forming machines then deposit the chips on belts forming them into mats. The particle mats are cured with heat and pressure, then trimmed and sanded.

Particle board is used extensively as the core for hardwood plywoods as well as shelves in cabinets and cupboards. Other uses include molded furniture, sheathing, and subflooring.

The advantage of particle board include lower cost than plywood and greater resistance to warpage.

The main disadvantage is that it does not hold screws or nails as well as plywood.

3. Chip Board

Chip board is made of layers of thin wafers of wood bonded together with phenolic resin. It is used for interior use as well as exterior sheathing. It is not very good for any exterior finish since water and dirt tend to get in behind the chips (or wafers).

4. Hardboard

Hardboard ('masonite') is made from processed wood chips. The chips are subjected to high-pressure steam in pressure vessels. When the pressure is released, the chips disintegrate. The wood cells (cellulose) and lignin (the natural glue-like material holding the cells of a tree together) are then separated from the unwanted elements. The cellulose and lignin are then mixed into a smooth liquid and spread evenly on a conveyor screen. The water drains off and a mat is formed. This mat is cut into convenient lengths. These are pressed into uniform, grainless sheets in heated presses.

Hardboards can be produced with one or both sides smooth.

They are produced in three grades.

(a) Standard - about 960 kg/m^3 but is flexible enough to be bent. It is light brown in color and the wide boards are available in 1200, 1800, 2400, 3000, 3600, or 4800 mm lengths and 3.2, 4.8, 6.4 or 7.9 mm thicknesses. Not suitable for exterior use unless the surface is protected from moisture by painting (X-90 siding).

(b) Low Density - about 800kg/m^3 and not as strong or durable as standard. Made 4.8 and 6.4 mm thick, 1200 mm wide, and in 1200, 1800, 2400, and 3000 mm lengths.

(c) Tempered - about 1120 kg/m^3. It is soaked with a compound of oils and resins, then baked. It is stronger and more durable than the other grades and it can be used on exterior work. It is stiffer, more brittle and made in the same thickness, widths and lengths as standard grade.

There is a wide variety of finishes available on hard boards; attractive imitation wood grain, leather texture, tile appearance, grooved to imitate planking, and treated with black dye.

Hardboard is also available as pegboard. Pegboard is available in two thicknesses, 3.2 mm with 3.2 mm holes and 6.4 mm thick with 6.4 mm holes.

5. Insulating Fiberboard

When making insulating fiberboard, wood is broken down into fibers. The fibers are mixed with water and spread onto a drum covered with wire mesh. The mat is peeled from the surface of the drum and passed through several sets of press rolls. It is then cut to size and fed into drying kilns. It should be noted that insulating fiberboard is not pressed.

Insulating fiberboard is commonly called ten-test and this product is made in two grades, insulating and sheathing.

(a) Insulating grade is commonly available in 11.1, 12.7, 15.9, 19 and 25.4 mm thickness but you can make thicker boards for roof insulation by cementing two or more sheets together. The 12.7 mm thickness is often used in panels, as decorative panels in varying widths (usually 2400 mm long), as ceiling tiles for houses 300 mm × 300 mm or 400 mm × 400 mm and for suspended ceiling systems 600 mm × 600 mm or 1200 × 600 mm. It is available in a variety of finishes and colors.

(b) Sheathing grade panels are either coated with asphalt or soaked with asphalt during manufacture. This type of insulating board is meant for exterior sheathing where moisture might be a problem. Both grades are used for insulating and sound control.

Insulating fiberboard does not have the strength of plywood panels and hence should not be used where strength and support is required.

FORMED WOOD PRODUCTS

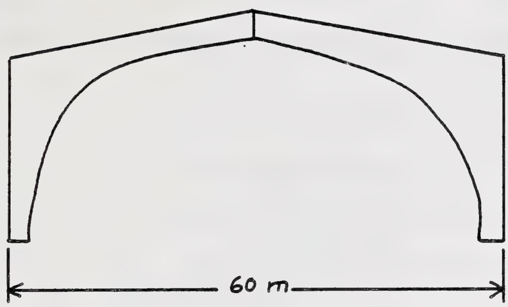
Wood is often shaped by cutting, planing, sanding, etc. However, it can also be shaped by combining, or laminating, several thin layers of wood. The scale of laminated wood products ranges from small delicate products, such as napkin rings, to large glued-laminated (glulam) posts, beams, and trusses (one-piece combination post beam). The most common laminated wood product is plywood sheets with hardwood or softwood faces.

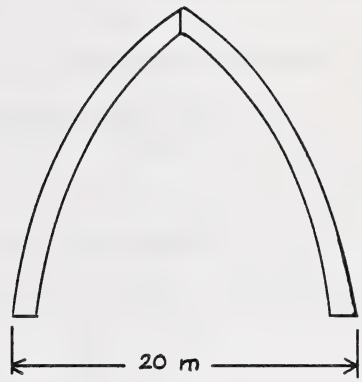
1. Glue Laminated Beams

Glue laminated (glulam) products are built up of several layers of wood whose grain directions are nearly parallel. This type of construction is often used for beams and posts. Because of the glued-laminated construction these beams and posts are stronger, less likely to twist and shrink, and are less likely to split than solid beams and posts. They can be made to almost any length, width, and depth.

The main difference between plywood and what is classified as gluelam products is that plywood is made of thin layers of wood with the crossbands running at right angles to the face veneers whereas glulam products are usually made of thicker layers of wood with the grain running as close to parallel as possible.

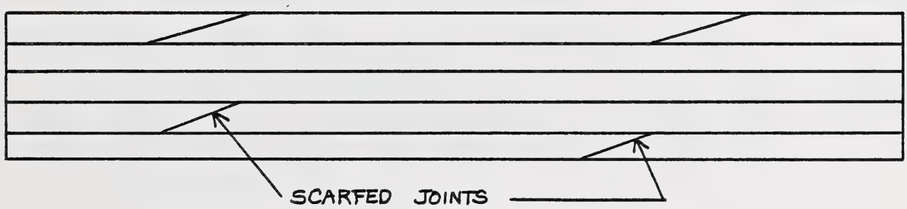
The big advantage of glulam beams is the fact that they can be made to any design as well as any size. Many styles of arches have been built using glulam construction.





Because they are made of wood they are not only strong but attractive as well and usually have a natural (clear) finish rather than paint.

Joints in glulam construction are usually scarfed.

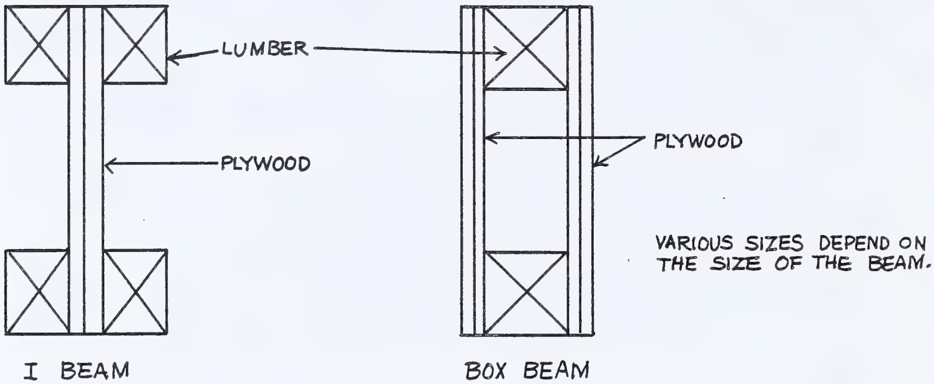


The biggest disadvantage of glulam construction is the large forming tables or platforms necessary on which to set up the jigs. Also, moisture content in the materials used must be very similar and high quality glue (expensive) should be used.

One simple glulam arch may be simply made by laminating spruce around a form or jig. The layers of wood are glued and nailed together. This would not be suitable for a large building with a great deal of stress but is a relatively inexpensive method of building a quonset style shelter. Machine sheds and small ice arenas have been constructed in this manner.

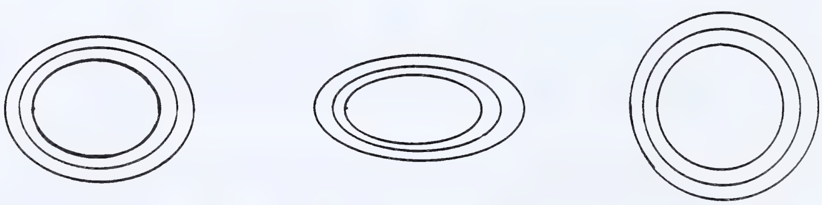
2. Box Beams and I Beams

Simple Box and I Beams can be made by combining plywood and dimension lumber.



3. Laminating

Products of unusual shape and for specific uses can be made by laminating thin strips of wood as well as the larger beams and arches. Laminating also gives the possibility of combining woods of different colors to give an attractive appearance. Also, a ruler, T-Square, nut bowl, etc. is less likely to warp or split than one cut out of a piece of solid wood. Small scrap pieces may be used instead of being discarded.



Oval and round shapes may be formed for magazine racks, chairs, wine racks, bookshelves, lamps, etc.

A pair of water skis is relatively easy to make, in fact almost any design can be formed. However, as the design becomes more complicated making the form and clamping the wood to it become more difficult, such as forming and clamping sides (or edges) of a guitar, violin, banjo, etc.

A piece of paper or polythene should be placed between the forms and the wood -- otherwise the wood you are forming may be glued to the form.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. Why is there a dark colored portion in each annual ring on a tree?

2. Why does a tree have medullary rays?

3. List the two systems used to classify hard and softwoods.

   (a)

   (b)

   Which system is most commonly used?

4. The word grain can mean many things when talking about lumber. Define each of the following words.

   (a) open grain

   (b) edge grain

   (c) even grain

5. Explain how a log is cut in order to produce edge grain lumber.

____

____

____

6. If you were building a hardwood cabinet, what type of grain would be considered best for appearance and strength?

____

____

7. List four conditions which contribute to rotting.

(a) ______________________________

(b) ______________________________

(c) ______________________________

(d) ______________________________

8. There are two ways to dry lumber. List the two ways and the moisture content of the wood after drying is complete.

(a) ______________ moisture content ______________.

(b) ______________ moisture content ______________.

9. Define the following terms.

(a) wane ______________________________

____

(b) crook ______________________________

____

(c) shake ______________________________

____

10. What is the major difference between the structural light framing and the structural joist and plank category of lumber?

____

____

____

11. List two places where you have seen beams and stringers used.

    (a) ______________________________

    (b) ______________________________

12. Where would a carpenter consider using appearance grade lumber?

    ____

    ____

13. How is the stud category different from the light framing category?

    ____

    ____

    ____

14. Poplar belongs to stress group ______________________________.

15. The grade stamp on a board lists the following information. Explain what each of the items mean.

    (a) A.F.P.A. 10

    ____

    ____

    (b) Hem-Fir

    ____

    ____

    (c) S Dry

    ____

    ____

    (d) 1

    ____

    ____

16. A certain wood costs $79.00/m^3$. You would like to buy 75 pieces - 40 mm × 100 mm × 3.0 m. What would it cost you? Show your calculations.

EXERCISE 2

1. Examine the sample blocks of wood, and fill out the table below, giving the appropriate letters for wood density and grain. List any defects you see. Especially note the common woods used in Western Canada for building and finishing (spruce, fir, hemlock, mahogany).

Wood	Hardwood (H) Softwood (S)	Grain Types			Thickness	Wood Defects
		Open (O) Close (C)	Edge (E) Flat (F) Angle (A)	Even (E) Medium (M) Coarse (C)		
1. Mahogany						
2. Oak						
3. Maple						
4. Walnut						
5. Birch						
6. Ash						
7. Hemlock						
8. Fir						
9. Spruce						
10. Pine						

2. The following questions deal with the plywood samples. Include the information asked for.

   (a) Spruce: Hard or soft?__________, Color __________ density __________

   (b) Pine: Hard or soft?__________, Color __________ density__________.

   Expain how you can tell the difference between spruce and pine.

   ____

   ____

   (c) Fir: Hard or soft?______________ Color ______________.

   Explain how you can tell the difference between spruce and fir.

   ____

   ____

3. How can you recognize the aspenite sample.

   ____

   ____

4. How is the K-3 made?______________________________

   ____

5. How does the density of K-3 compare to spruce plywood?

   ____

6. What does the term 'good one side' mean?

   ____

   ____

7. How is G1S plywood different from S1S plywood of the same type.

   ____

   ____

8. Was a sample of sheathing enclosed? If so, how is it different from the G1S and S1S plywood?

   ____

   ____

   ____

EXERCISE 3

1. Why does plywood have a great resistance to splitting as it is being nailed?

2. Why is some plywood made with a particle core?

3. Which grade of plywood is best for making a sign which will be outdoors?

4. Give four reasons how glulam beams are different from solid wood beams.

5. Which woods are of disparate (unequal and varying) strength but have similar exceptional resistance to decay?

6. What is the difference between a defect and a blemish on a piece of board?

7. Which category of lumber should be specified for making prefab truss rafters?

END OF LESSON 12

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted

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Time Spent on Lesson

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(If label is missing
or incorrect)

File Number

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Lesson Number ____________

Student's Questions and Comments

Apply Lesson Label Here

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Please verify that preprinted label is for correct course and lesson.

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Teacher: ____________

Lesson Grading: ____________

Additional Grading
E/R/P Code: ____________

Mark: ____________

Graded by: ____________

Assignment Code: ____________

Date Lesson Received:

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Lesson Recorded ______

Teacher's Comments:

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Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

TRADE MATHEMATICS II

You have studied the addition and subtraction of numbers in Lesson 11. In this lesson you are going to study another important arithmetical procedure, namely Multiplication. You will also deal with applications of this procedure as in finding areas and volumes of objects.

Much of this material will be familiar to most students. Therefore these students should regard this lesson as a review exercise. All self correcting exercises should be completed but are not required to be sent in for correction. They can be used to check a students speed and accuracy in performing calculations.

In the construction industry, mathematical accuracy is much more important than simple speed. A workman who saves ten seconds on a calculation, but who wastes an hour because that calculation was inaccurate, is really wasting time, temper, and material.

We do advise students to read through the entire lesson, as we have gone into the procedures in considerable detail. Students may very likely be able to refresh their memory on minor, but still important details.

MULTIPLICATION

1. Multiplication of Simple Numbers

Most calculations in building or in industry will involve either multiplication or division. Multiplication facts are essential to both these operations and skill with these facts is necessary for division.

Let us review some of those multiplication facts.

SELF CORRECTING EXERCISE 1

Fill in the blanks in the following tables with the correct numbers.

6 × 1 = 6	7 × 1 = 7	8 × 1 = 8
6 × 2 = 12	7 × 2 = 14	8 × 2 = 16
6 × 3 = 18	7 × 3 = ___	8 × 3 = ___
6 × 4 = ___	7 × 4 = 28	8 × 4 = 32
6 × 5 = 30	7 × 5 = ___	8 × 5 = ___
6 × 6 = ___	7 × 6 = 42	8 × 6 = 48
6 × 7 = 42	7 × 7 = ___	8 × 7 = ___
6 × 8 = ___	7 × 8 = 56	8 × 8 = ___
6 × 9 = 54	7 × 9 = ___	8 × 9 = ___
6 × 10 = ___	7 × 10 = 70	8 × 10 = 80

9 × 1 = 9	12 × 1 = 12	16 × 1 = 16
9 × 2 = ____	12 × 2 = ____	16 × 2 = ____
9 × 3 = 27	12 × 3 = 36	16 × 3 = ____
9 × 4 = ____	12 × 4 = ____	16 × 4 = ____
9 × 5 = 45	12 × 5 = 60	16 × 5 = 80
9 × 6 = ____	12 × 6 = ____	16 × 6 = 96
9 × 7 = 63	12 × 7 = 84	16 × 7 = ____
9 × 8 = ____	12 × 8 = ____	16 × 8 = ____
9 × 9 = ____	12 × 9 = ____	16 × 9 = ____
9 × 10 = 90	12 × 10 = 120	16 × 10 = 160

SELF CORRECTING EXERCISE 2

Perform the following multiplications.

(a)
$$\begin{array}{r} 793 \\ 19 \\ \hline \end{array}$$

(b)
$$\begin{array}{r} 1070 \\ 93 \\ \hline \end{array}$$

(c)
$$\begin{array}{r} 4606 \\ 1007 \\ \hline \end{array}$$

(d)
$$\begin{array}{r} 5947 \\ 346 \\ \hline \end{array}$$

2. Multiplication of Decimal Values

So far, you have multiplied only whole numbers. Whole numbers are all located to the left of the decimal point and, while the decimal point is actually there, it is never written in. Thus, 365 is actually 365.

When a decimal value is multiplied by a decimal value, we can do the actual multiplication by the numbers as if they were whole numbers. The problem arises in locating the decimal point in the product. Let us multiply some simple decimal values first.

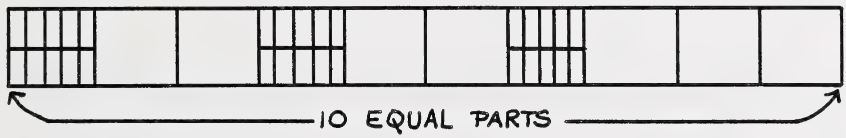
Suppose we were given the followng problem to multiply.

$$\begin{array}{r} 0.3 \\ \times 0.1 \\ \hline \end{array}$$

Our answer would be 3, but where is the decimal point?

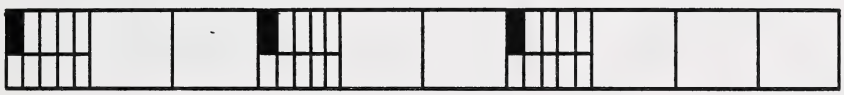
Let us examine just what the multiplication means.

0.3 means that we have 3 tenths of the object or 3 of 10 equal parts, as in this diagram.



To multiply this by 0.1 means that we are asked to take 1 tenth part of each of those 3 equal parts.

We will have a diagram like this.



If we subdivide our large figure into the same sized parts as we have shaded in, we will have a figure like this.

So, we can see that one tenth of three tenths is three one hundredths of the entire figure.

So, our multiplication becomes

$$\begin{array}{r} 0.3 \\ \times 0.1 \\ \hline 0.03 \end{array}$$

From this we can derive the rule for locating the decimal point in the product of decimal values.

The number of digits to the right of the decimal point in the product is equal to the sum of the number of digits to the right of the decimal point in each of the two factors.

SELF CORRECTING EXERCISE 3

Perform the following multiplications.

(a) $\begin{array}{r} 19.495 \\ \underline{6.31} \end{array}$

(b) $\begin{array}{r} 1.009 \\ \underline{0.0911} \end{array}$

(c) $\begin{array}{r} 978.3 \\ \underline{10} \end{array}$

(d) $\begin{array}{r} 978.3 \\ \underline{100} \end{array}$

(e) $\begin{array}{r} 978.3 \\ \underline{0.1} \end{array}$

(f) $\begin{array}{r} 978.3 \\ \underline{0.01} \end{array}$

3. Multiplication of Fractional Values

When we multiply by fractional values, we are doing something very similar to working with decimals. It was mentioned in the last section that 0.1×0.3 was one-tenth part of three tenths. We obtained our answer as 0.03 or three hundredths.

If we were to write these values as fractions we would have

$$3/10 \times 1/10 = 3/100$$

Notice that the numerator of our product is equal to 3×1 or 3, which is the product of the numerator, and the denominator of our product is equal to 10×10, or 100, which is the product of our denominators.

> When any two fractional values are multiplied, the numerator of the new fraction is the product of the given numerators and the denominator of the new fraction is the product of the given denominators.

4. Muliplication of Mixed Numbers

A mixed number is a whole number plus a fractional number.

Thus $4\frac{7}{8}$ is $4 + \frac{7}{8}$.

Suppose we were to multiply $4\frac{7}{8}$ by $\frac{1}{4}$ as in

$$4\frac{7}{8} \times \frac{1}{4}$$

The correct way to do this problem is to transform the mixed number into a fractional number and then follow the rules for multiplying fractional values. 4 is 4 whole units, which are 4×8 or 32 eights. Thus $4 + \frac{7}{8}$ becomes $\frac{32}{8} + \frac{7}{8}$ or $\frac{39}{8}$.

Now our problem becomes

$$\frac{39}{8} \times \frac{1}{4}$$

$$= \frac{39 \times 1}{8 \times 4}$$

$$= \frac{39}{32}$$

$$= 1\frac{7}{32}$$

SELF CORRECTING EXERCISE 4

Perform the following multiplications.

(a) $\frac{1}{4} \times \frac{1}{4}$

(b) $\frac{7}{8} \times \frac{3}{16}$

(c) $3\frac{1}{8} \times 2\frac{1}{8}$

$= \left(\frac{24}{8} + \frac{1}{8}\right) \times \left(\frac{16}{8} + \frac{1}{8}\right)$

$= \frac{25}{8} \times \frac{17}{8}$

$= \frac{425}{64}$

$= 6\frac{41}{64}$

(d) $1\frac{1}{4} \times 2\frac{1}{8} =$

(e) $2\frac{7}{16} \times \frac{5}{8} =$

(f) $1\frac{1}{8} \times 2\frac{1}{4} =$

PERIMETER AND CIRCUMFERENCE

In this topic we will discuss the distance around the outside edge of a figure. In effect, we can think of this distance as if we took a cord and wrapped it once around our figure, and then stretched the cord out and measured it.

This, in most cases, is a very clumsy way of indicating distance. You will be shown a mathematical way in which to calculate distances.

You will first study figures having straight sides. Such figures are called *polygons.*

The distance around a straight-sided figure is the Perimeter of that figure.

1. The Triangle

A triangle with each of the three sides in a different length is a Scalene Triangle.

A triangle with two sides the same length is an Isosceles Triangle.

A triangle with all three sides the same length is an Equilateral Triangle.

If we are asked to find the perimeter of a scalene triangle, there is only one way we can do it.

(a) We must simply add up the lengths of the three sides.

If we are asked to find the perimeter of an isosceles triangle we can:

(a) Add up the lengths of the three sides.
(b) Multiply the length of the congruent scales by 2 and add the length of the third side to the product.

If we are asked to find the perimeter of an equilateral triangle we can:

(a) Add up the lengths of the three sides.
(b) Multiply the length of one side by 3.

SELF CORRECTING EXERCISE 5

Identify each triangle and then find its perimeter from dimensions given. Units must be included in the answer.

(a) 6 m 6 m 6 m

This is an equilateral triangle.

Perimeter is 6 m × 3 = 18 m

(b) 8 m 6 m 8 m

(c) 17 m 10 m 18 m

(d) 9 mm 9 mm 9 mm

Let us now examine figures with four scales. Generally, most areas in construction have four scales and have right angles, simply because this is the easiest shape to use in construction.

2. The Rectangle

A four sided plane figure having all its interior angles right angles is a Rectangle.

When we construct any rectangle, we find one very obvious fact.

In any rectangle the opposite sides are the same length.

Suppose we have a rectangle whose length is 'l' units and whose width is 'w' units.

$$P = l + w + l + w$$

Which can be written as $P = l + l + w + w$

or

$$P = 2l \text{ or } 2w$$

The Perimeter of a rectangle is found by the formula $P = 2l + 2w$

3. The Square

A Rectangle with four equal sides is a Square

Perimeter is S + S + S + S = 4S

The Perimeter of a square is found by the formula

$$P = 4S$$

SELF CORRECTING EXERCISE 6

Find the perimeter of each of the following rectangular figures. Answers must include the correct metric units.

(a) 24 mm by 18 mm

$P = 2l + 2w$
$P = 2(24) + 2(18)$
$= 48 + 36$
$P = 84$ mm

(b) 9 m by 9 m

(c) 106 m by 32 m

(d) 99 m × 48 m

(e) a square whose sides are 17 mm long

(f) a square 64 cm by 64 cm

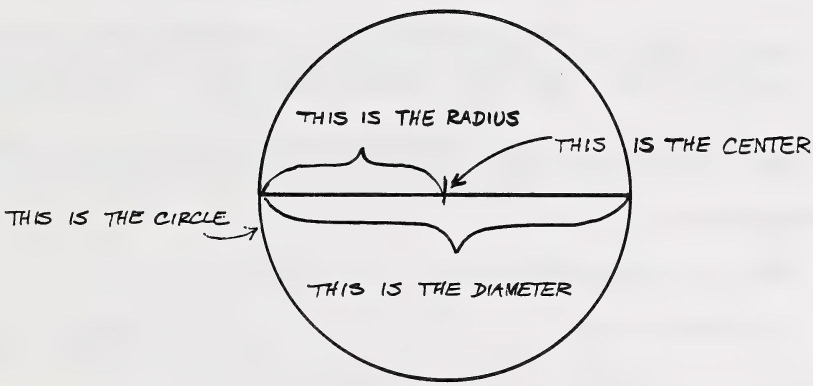
4. The Circle

So far in this lesson we have discussed figures with straight outer edges. Such figures are given the general name of of polygons. Now let us consider a figure with a curved outer edge.

> A circle is defined as a row of points, each of which is the same distance from a given point, called the Centre of the Circle.

> The distance from the Centre to the Circle is the Radius of that Circle.

> The length of a line segment which passes through the centre and has each end on the circle is the Diameter of that Circle.



By our definition of a circle each point is the same distance from the centre. Therefore, any radius is the same length as any other radius of that same circle.

From the above diagram, the diameter actually is composed of two radii, one from the centre going to the circle in one direction and the second radius going from the centre to the circle in the opposite direction.

> The length of a Diameter is twice the length of a Radius.

When we go about finding the distance around the figure, we cannot use any of the techniques used to find the perimeter of a polygon. In fact, we do not even call the distance around a circle a perimeter.

> The distance around a Circle is the Circumference of that Circle.

Distances are always measured as if we were dealing with a straight line, and the easiest distance to measure, on a circle, is the diameter of that circle. Mathematicians have found a relationship between the diameter and the circumference of a circle. They call the number by the Greek letter π , pronounced 'pie'.

> The Circumference of any circle can be found by the formula
>
> $$C = \pi d$$

The value of π does not change but, it is an unrational number. Therefore it cannot be expressed as a simple fraction. It has been calculated to at least 20 decimal places. For ordinary work, and in this course, the values of π can be taken as 3.14.

The value of π is used to calculate the circumference of a circle. Later in this course you will be shown how it is also used to calculate the area of a circle.

SELF CORRECTING EXERCISE 7

Calculate the circumferences of each circle. Use correct metric units.

(a) Diameter of 7 cm

$C = \pi d$

$C = 3.14 \times 7$

$= 21.98 \text{ cm}$

(b) Radius of 14 mm

$C = 2\pi r$

$C = 2 \times 3.14 \times 14$

$C = 87.92 \text{ mm}$

(c) Diameter of 3.5 m

(d) Radius of 3 mm

(e) Diameter of 21 m

(f) Diameter of 63 cm

AREA

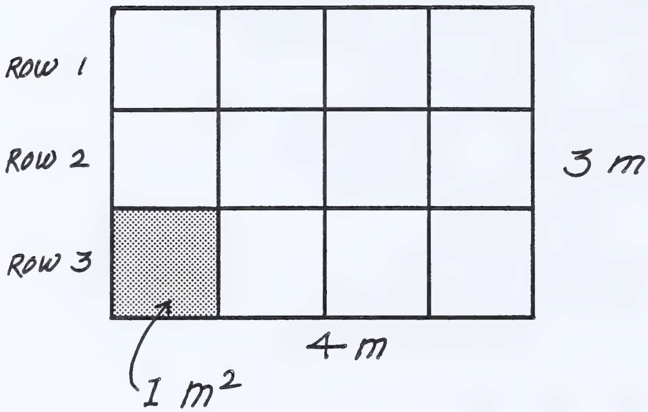
Perimeter and circumference are linear measure. For example, if we could put a cord around the outside edge of the figure and then pull that cord out straight, we would be able to find the distance around that figure with the aid of a simple ruler.

When we consider area, we must consider all the space within the boundaries of the figure. For this job we can no longer use simple linear measure.

Just as lengths are broken up into standard units of millimetres or metres, so our space can be broken up into square units of space, based on the metre. Thus a square metre will be what its name indicates, that is, a square which measures 1 m on each side. Similarly, a square centimetre measures 1 cm on each side and a mm^2 measures 1 mm on each side.

1. Rectangular Figures

Let us now develop a method of calculating the area of a rectangular figure, as in the following diagram.



Note that the correct SI symbols are m^2, cm^2, mm^2 ('sq. m.' or 'c.c.' or 'sq. cm' is NOT acceptable.)

SELF CORRECTING EXERCISE 8

(a) The length of the rectangle is ____________________.

(b) The width of the rectangle is ____________________.

(c) The total number of squares can be found by multiplying the number of squares in one row by the number of ____________________.

(d) (i) The total number of squares in the rectangle is ____________________.

(ii) if 'ℓ' units represents the measure of the length of a rectangle and 'w' units represent the measure of the width of a rectangle, the number of square units enclosed by the rectangle is expressed by the product

____

(e) The formula in words for finding the area of the region enclosed by a rectangle is:

Area = ____________________ × ____________________.

FORMULA FOR

AREA OF A RECTANGLE

$A = \ell w$

SELF CORRECTING EXERCISE 9

Find the areas of the rectangles whose dimensions are given. Be sure you include the correct units.

(a) 20 cm × 15 cm

$A = lw$

$A = 20 \times 15$

$A = 300\ cm^2$

(b) 4.7 cm × 2.3 cm

(c) 6 m × 6 m

(d) 7.5 m × 3.6 m

A square is a particular type of rectangle in which each side is the same measure. The formula for area which is

$$A = \ell w$$

$$\text{becomes } A = s \times s$$

$$\text{or } A = s^2$$

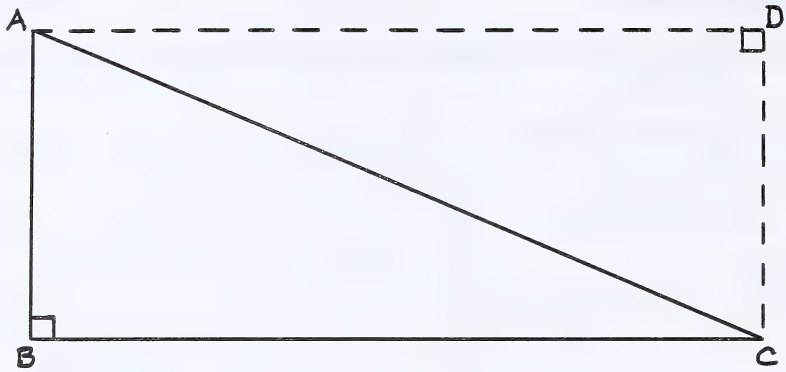
*Note that s^2 means s × s NOT 2 × s.

So 5^2 means 5 × 5 NOT 5 × 2 or 2 × 5.

Make sure you understand this point before going any further in the lesson.

2. Triangular Figures

If we draw a right triangle, such as △ ABC on page 14, we can find its area in the following manner.



We can construct a second triangle, exactly the same size as $\triangle ABC$, on the hypotenuse $\overline{AC}$. Let use call this second triangle $\triangle ADC$.

Now, if we examine the figure ABCD, we find that we have a rectangle, because the angles are right angles and the opposite sides are equal in length.

The area of ABCD is ℓw, that is, the length $\overline{BC}$ multiplied by the length of $\overline{AB}$.

Since $\triangle ABC$ is one half of ABCD then the area of $\triangle ABC$ is $\frac{1}{2}$ BC $\times$ AB.

In triangles we call BC the length of the base of the triangle and AB the height of the triangle.

So this area of a right triangle is equal to $\frac{1}{2}$ base $\times$ height.

> The Area of a Right Triangle is given by the formula
>
> $$A = \tfrac{1}{2}bh$$

SELF CORRECTING EXERCISE 10

Find the areas of the following triangles.

(a) Base 12 m, height 6 m

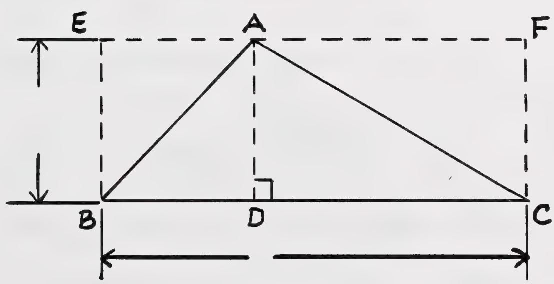
(b) Base 18 mm, height 9 mm

(c) Base 3 cm, height 12 cm

(d) Base 3.6 m, height 3.75 m

This is fine for right angled triangles, but suppose we have a triangle which does not contain a right angle?

We simply convert that triangle into two right triangles by dropping a perpendicular from one vertex to the opposite side in this diagram.



Here we have $\triangle ABC$ with a base of 10 m.

To find the area, we drop a perpendicular $\overline{AD}$ from A to $\overline{BC}$. Now we have two right triangles, namely $\triangle ABD$ and $\triangle ADC$. As we showed in the last section, $\triangle ABD$ is ½ of ADBE and $\triangle ADC$ is ½ of ADCF.

Which makes the total area of $\triangle ABC$, ½ the total area of EBCF.

By simply measuring the length of $\overline{AD}$ we find that it would be 5.

So our area of $\triangle ABC$ is $\frac{1}{2} \times 10 \times 5$ or 25 m^2.

The Area of any Triangle is found by the formula

$$A = \tfrac{1}{2}bh$$

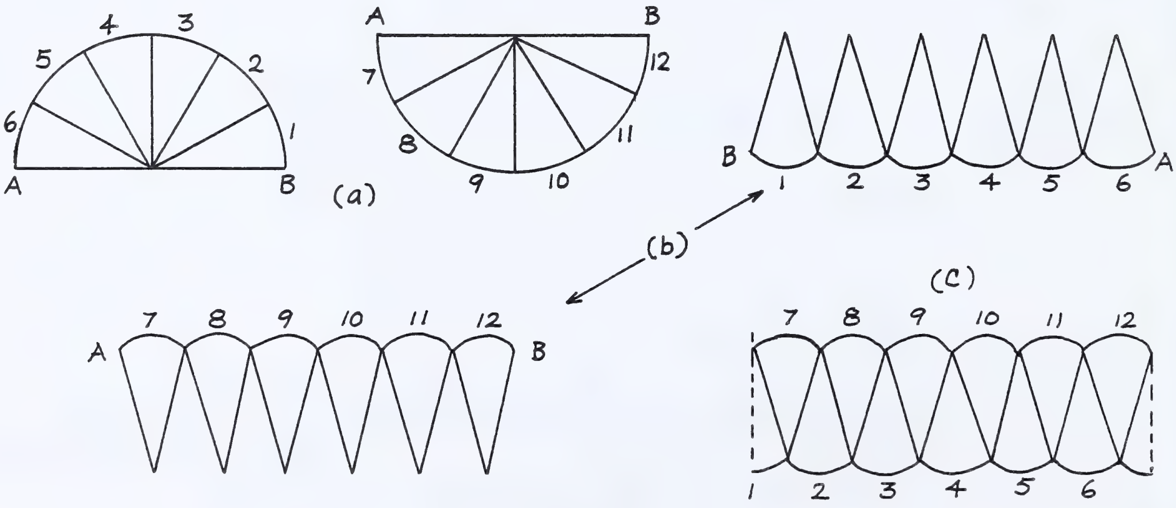
SELF CORRECTING EXERCISE 11

Find the areas of the following triangles.

(a) Base 13 m, Height 12 m

(b) Base 9 cm, Height 4.6 cm

3. Circles



A circular region has been cut into two semicircular regions of the same size. Each of these semicircular regions has been divided into small sectors and these sectors have been stretched out (b part of the diagram) to form two sections resembling jagged teeth. These two sections have been fitted or meshed together to form a figure very much like a parallelogram (c part). If we cut the original circular region into a larger number of very small tooth-like pieces, then the meshed figure would more closely resemble a parallelogram. If we take one half of segment 1 and place it onto segment 12, we will have the form of a rectangle.

(a) With reference to the preceeding diagrams:

(i) The height of the rectangle = the measure of the radius of the circle.

(ii) The measure of the base of the rectangle = one half of the circumference of the circle.

(b) The formula for the area of a rectangle is:

Area = measure of the base × measure of the height.

For the rectangle in (c) above the area formula would be:

$A = r \times \frac{1}{2}c$, where r represents the measure of the height of the rectangle

and $\frac{1}{2}c$ represents the measure of the base of the rectangle.

The circumference formula is $c = \pi d$

so that the formula for one-half the circumference is:

$$\tfrac{1}{2}c = \tfrac{1}{2} \times \pi \times d.$$

Now replace $\frac{1}{2}c$ in the area formula $A = r \times \frac{1}{2}c$.

$$A = r \times \overbrace{\tfrac{1}{2} \times \pi \times d}^{\frac{1}{2}c}$$

The length of the diameter is twice the radius length so $d = 2 \times r$.

Replace d in the area formula by 2r to give $A = r \times \frac{1}{2} \times \pi \times 2r$.

Use the commutative
and associative properties: $A = (r \times r) \times (\frac{1}{2} \times 2) \times \pi$

$(r \times r = r^2)$ $(\frac{1}{2} \times 2 = 1)$

$$A = \pi \times r^2$$

FORMULA

AREA OF A CIRCLE

$A = \pi r^2$

REMEMBER that r^2 means $r \times r$ NOT $r \times 2$.

SELF-CORRECTING EXERCISE 12

Find the area of each of the following circles whose radius is given.

(a) 21 m

$A = \pi r^2$
$A = 3.14 \times 21 \times 21$
$A =$

(b) 49 cm

The most easily measured dimension of a circle is the diameter. The radius must be found before calculating the area. Find the areas of each circle, whose diameter is given (Diameter = 2 Radii)

(a) 14 mm

~~so~~ $r = 7mm$
$A = \pi r^2$
$A = 3.14 \times 7 \times 7$
$A =$

(b) 2 km

(c) 8 mm

(d) 17 cm

Supplement to Metric Areas

Areas are usually expressed in square centimetres (cm^2). square metres (m^2) or square kilometres (km^2).

The square centimetre is useful in stating the area of tiles and window glass.

The square metre is useful in stating the area of carpets, floor space, or paint coverage.

The square kilometre may be used to denote areas of land or water.

You may know that 100 cm = 1 m and 1 km = 1000 m but be careful when calculating metric areas as errors can easily be made.

EXAMPLE 1: How may square centimetres in 9 m^2?

Since 1 m = 100 cm
then $(1m)^2 = (100\ cm)^2$
$= (100 \times 100)\ cm^2$
So $1m^2 = 10\ 000\ cm^2$

EXAMPLE 2: How many km^2 in $1m^2$?

Since 1000 m = 1 km
then 1 m = 0.001 km
and $(1m)^2 = (0.001km)^2$
$= (0.001 \times 0.001)km^2$
$= (0.000001)\ km^2$
So $1\ m^2 = 1 \times 10^{-6} km^2$

The key to calculating metric areas is to be careful and sure of what you are doing in each step of the calculation.

VOLUME

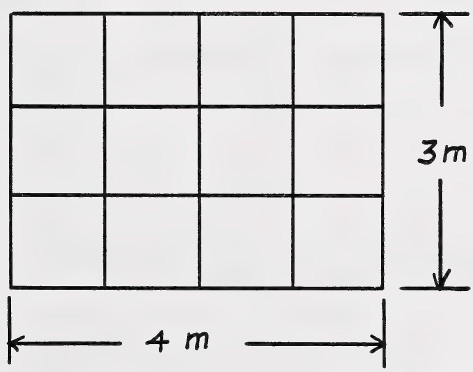
Area involves two dimensions, length, and width. Volume is concerned with three dimensions, length, width, and height.

Just as we had to have square units (such as square metres) in order to measure area, so we must have cubic units (such as cubic metres, cubic centimetres and cubic millimetres) to measure volumes. These units are written as m^3, cm^3 and mm^3.

1. Rectangular Figures

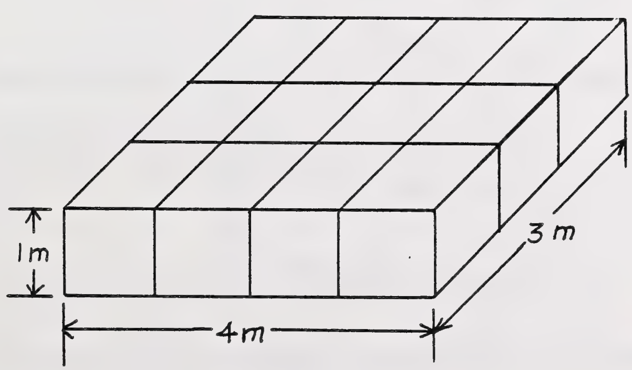
We will consider a rectangular figure as one in which each face or side of the figure is a rectangle.

Suppose we have a figure that covers a space like this.



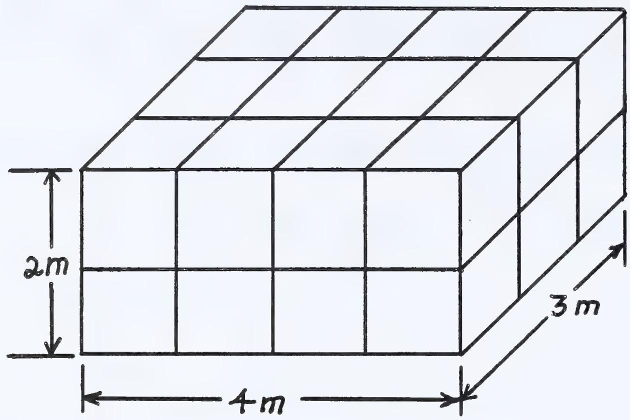
We can see that the area it covers is 12 m^2, which is the same as the area of the end of the figure.

If the figure is 1 m high, then we will have something that looks like this.



We have 12 m^3, which can be calculated by multiplying our area by 1, which is the height of our figure.

If we add a second layer we get a figure which looks like this.



We now have 24 m^3, which can be calculated by multiplying our area by 2, which is the height of our figure.

> The volume of a straight-sided object is found by multiplying the area of one end by the height of that figure.

Expressed in symbols, our volume is

$$V = Ah$$

but, in the case of a figure with a rectangular base

$$A = \ell w$$

So our volume for a rectangular solid can be stated by this formula

> The Volume of a Rectangular Solid is found by the formula
>
> $$V = \ell\ w\ h$$

SELF CORRECTING EXERCISE 13

Find the volumes of the following rectangular figures.

(a) 12 m × 8 m × 10 m

(b) 18 cm × 4 cm × 3 cm

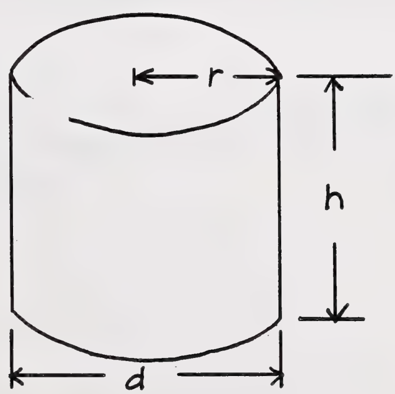
(c) 96 m × 48 m × 75 cm

(d) 2.75 m × 1.5 m × 3.7 m

2. Cylindrical Figures

So far in this lesson we have discussed rectangular figures which have a rectangle on each face.

Suppose we have a cylinder as in the diagram below.



The radius of the end circles is r units, the diameter of those ends is d units and the length or height of the cylinder is h units.

To find the volume of this cylinder we can use the same idea as we used in finding the other volumes. If the volume of a rectangular solid is the area of one end multiplied by the height, then the volume of a cylinder can be found in the same manner ... The area of one end is πr^2 ... so ...

> The Volume of the Cylinder is found by the formula
>
> $$V = \pi r^2 h$$

SELF CORRECTING EXERCISE 14

Find the volumes of the following cylinders.

(a) Radius is 7 m
height is 10 m

(b) Radius is 21 cm
height is 15 cm

(c) Diameter is 28 cm
length is 12 cm

(d) Diameter is 15 cm
length is 28 cm

Complete the following exercises and send them in for correction

EXERCISE 1

Multiply the following.

(a) $\begin{array}{r} 46 \\ \underline{908} \end{array}$

(b) $\begin{array}{r} 499 \\ \underline{7909} \end{array}$

(c) $\begin{array}{r} 9070 \\ \underline{367} \end{array}$

(d) $\begin{array}{r} 87.41 \\ \underline{9.37} \end{array}$

(e) $\begin{array}{r} 98.04 \\ \underline{10.9} \end{array}$

(f) $\begin{array}{r} 107.37 \\ \underline{0.033} \end{array}$

(g) $9 \frac{7}{16} \times \frac{1}{2}$

(h) $3 \frac{3}{4} \times 4 \frac{7}{8}$

EXERCISE 2

An equilateral triangle shaped piece of land has a side of 140 m. What is the perimeter and area of this land? (Remember the height must be calculated before finding the area.)

EXERCISE 3

A 25 cm diameter hole has to be cut in the center of each of five 1 m square boards. How many cm^2 of material are removed in total from all five boards?

EXERCISE 4

A paint can with an interior diameter of 18 cm is filled to a height of 26 cm with blue paint. What is the volume, in cm^2, of the paint inside of the can? If 10 cm^3 of this paint can cover a wall surface 0.75 m^2, how many m^2 of surface will be covered by the entire amount of paint in the can?

EXERCISE 5

Complete each of the following questions showing your work as to how you calculated each answer. Diagrams may help you answer each question correctly.

1. A vacant city lot measures 225 m × 100 m. If a roll of fencing measures 210 m, will one roll of this fencing be enough to enclose this lot and leave a 14 m gateway?

2. Find the amount of wood left over in a piece of 4 m × 4 m board, when the largest possible circle is cut out from it.

3. How many m^3 of material are removed from a cellar that measures 20 m by 18 m by 9 m?

4. Find the area to be wallpapered in the walls of a room 4 m long by 2.4 m wide by 3 m high, if there are two doors 2 m by 1 m and 4 windows 1 m by 1 m.

5. A man buys a circular wading pool for his children which is 3 m in diameter. If the pool is 50 cm deep, how many litres of water will it hold?
(Hint: 1000 cm^3 = 1 L)

6. A granary is 14 m × 12 m × 8 m. The gable ends rise 4 m. How many m^2 of surface would there be to paint on such a building?

7. A washroom floor that is 12 m × 9 m will be covered with 2 cm square tiles. How many tiles will be needed?

Answers to Self Correcting Exercises

S.C.E. 1 -	24	21	24	18	24	32
	36	35	40	36	48	48
	48	49	56	54	72	64
	60	63	64	72	96	112
			72	81	108	128
						144

S.C.E. 2 - (a) 15 067, (b) 99 510, (c) 4 638 242, (d) 2 057 662

S.C.E. 3 - (a) 123.013, (b) 0.0919 (c) 9783, (d) 97 830
(e) 97.83, (f) 9.783

S.C.E. 4 - (a) 1/16, (b) 21/128, (d) 2 21/32, (e) 1 67/128, (f) 2 17/32

S.C.E. 5 - (b) 22 m, (c) 45 m, (d) 27 mm

S.C.E. 6 - (b) 36 m, (c) 276 m, (d) 294 m, (e) 68 mm, (f) 256 cm

S.C.E. 7 - (c) 10.99 m, (d) 18.84 mm, (e) 65.94 m, (f) 197.83 cm

S.C.E. 8 -	(a)	4 m, (b) 3 m, (c) squares in the other row (ci) 12, (cii) lw
	(e)	length × width
S.C.E. 9 -	(b)	10.81 cm^2, (c) 36 m^2, (d) 27 m^2
S.C.E. 10 -	(a)	36 m^2, (b) 81 mm^2, (c) 18 cm^2, (d) 6.75 m^2
S.C.E. 11 -	(a)	78 m^2, (b) 20.7 cm^2
S.C.E. 12 -	(a)	1 384.74 m^2, (b) 7 539.14 cm^2, (a) 153.86 mm^2
	(b)	3.14 km^2, (c) 50.24 mm^2, (d) 226.86 cm^2
S.C.E. 13 -	(a)	960 m^3, (b) 216 cm^3, (c) 3 456 m^3, (d) 15.2625 m^3
S.C.E. 14 -	(a)	1 538.6 m^3, (b) 20 771.1 cm^3, (c) 7385.28 cm^3
	(d)	4 945.50 cm^3

END OF LESSON 13

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________________

Time Spent on Lesson ____________________

(If label is missing or incorrect)

File Number ____________________

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ______

Additional Grading E/R/P Code: ______

Mark: ________

Graded by: ________

Assignment Code: _____

Date Lesson Received: ____________________

Lesson Recorded _____

Student's Questions and Comments

Apply Lesson Label Here

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Please verify that preprinted label is for correct course and lesson.

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Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

PLANNING AND DESIGN I

INTRODUCTION

Drafting instruments
Scales
Drawing to scale
Common scales in use
Drawing horizontal and vertical lines
Drafting paper
Positioning the drawing sheet
Laying out the drawing sheet

To construct an object as required, a worker must have a clear idea of the shape and definite, accurate information about the size, details, special processes, materials, and finish. Time would be wasted in explaining to the worker the shape and size of the object and how it is to be constructed. A working drawing accurately gives all this information needed to make a project. It shows with a few lines, symbols, and notes what would take considerable time to explain.

The value of any technical drawing depends totally on how skillfully the draftsman can present the given data on the object to be drawn. This degree of skill is to a considerable amount governed by how well the various drafting instruments and materials are used. This lesson is designed to give the student drafting a project some basic suggestions in how this equipment can be used to obtain good results, as well as some information about the instruments themselves.

DRAFTING INSTRUMENTS

1. Drawing Pencils

The pencil is one of the draftsman's most important tools. All drawing in drafting is first done with a pencil. Later you may learn to ink your drawings, but even an ink drawing is always drawn first in pencil. For this reason drawing pencils should be carefully selected and be skilfully prepared for use.

The hardness of pencil lead to be used depends almost entirely on such factors as grade of paper and kinds of lines required. The softness or hardness of the lead in a pencil is known as the grade of the pencil. Soft leads give a very black line with little pressure put on the pencil, while hard leads yield a grayer line. There are seventeen different grades of black lead pencil, ranging from 7B (extremely soft) to 9H (extremely hard). Grades of 2B, 3B, 4B, up to 7B are progressively softer than H. Soft pencils are used by artists, not by draftsmen. The grade of lead is marked on one end of a pencil or in the case of the ejector semi-automatic pencil, the grade is marked near the end of the lead.

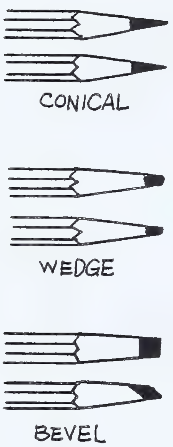
In this course you are to use pencils of two grades only: H and 4H. These pencils are readily available in stores in Alberta. The H pencil will serve to construct the thick lines while the 4H pencil will be used to construct thin lines.

DO ALL WORK IN THE DRAFTING LESSONS WITH 4H AND H PENCILS

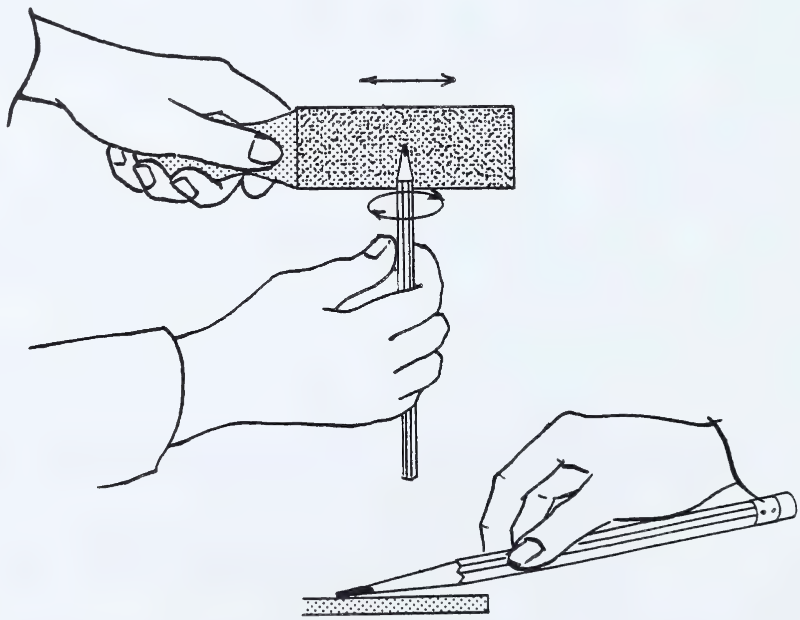
Do the preliminary work on all your drawings with the 4H pencil. We shall require mainly two weights of lines:

Light lines -- these are drawn with the 4H pencil.
Heavy lines -- these are ALSO drawn with the 4H pencil and then gone over or heavied up with the H pencil.

In other words, for our purposes the 4H pencil is our hard pencil, and the H pencil is our soft pencil.



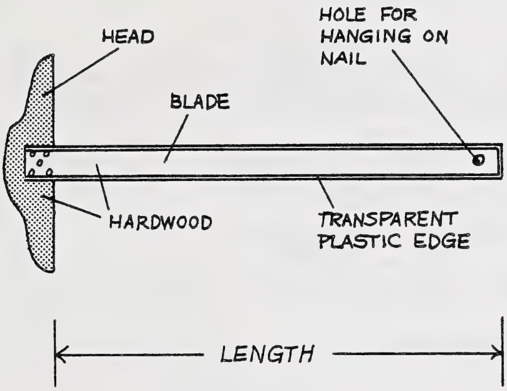
When sharpening wood - bonded pencils, first shape the wood back with a knife or mechanical sharpener. You should then sand the point of the lead to one of three types of points by sanding it on a sanding pad or file, or by using a mechanical pointer. In this course a sanding block is recommended for use by students (a piece of fine sanding paper may be used instead). The drawings below show how a sanding block may be used to dress the pencil lead. The three types of pencil points which can be used are shown to the left. The student may choose the type of point that gives him the best results. Most students in this course find the conical point easiest to point (sharpen) and keep to a consistent thickness when using.



ROLL AND SHARPEN THE POINT ON THE SANDPAPER PAD.

Many draftsmen prefer to use an ejector type, semi-automatic pencil which holds a long drawing lead. The lead is ejected from the pencil to the desired length (10 mm) and is then sharpened in the same manner as the wood-bonded pencil.

2. The T-Square



The name T-square is derived from its shape. This instrument is primarily used to draw horizontal lines, but is also effectively used as a guide for set squares to draw vertical or sloping lines. It consists of two main parts, the head and the blade. The head is securely attached to the blade by screws.

To check the accuracy of a T-square, the following procedure may be followed.

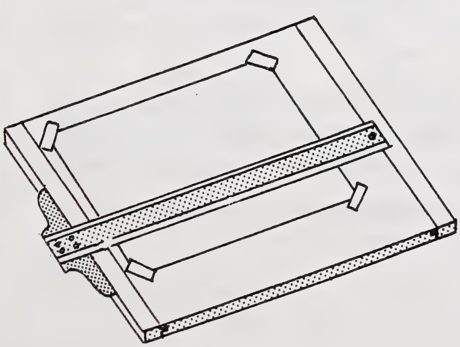
(a) Place the edge of the head against any straight edge and determine if there exists any rocking motion of the head on this surface.

(b) To check the blade edge of the T-square as well as the squareness of the instrument, fasten a sheet of drawing paper to the board as outlined below. Place the head of the T-square on the left side of the board, and draw a horizontal line across the paper. Now, placing the head on the right side of the board, try to align both ends of the line with the edge of the T-Square. Draw a line. If any error is present in the instrument, these lines will not coincide. Obviously, it is mandatory that the board is perfectly square; that the working edges of the board are true, when checking the T-square in this manner.

It is recommended that the student obtain a T-square of wood and plastic construction of about 70 cm in length. Usually these T-squares have an ebony finished head and a hardwood blade with transparent plastic edges. There are usually five screws that fasten the head to the blade.

3. The Drawing Board

All drawing, except sketching, should be done on a drawing board whenever possible. The drawing board provides a smooth working surface and also serves as a guide for the T-square. The T-square and drawing board together provide the means by which all horizontal and vertical lines are kept parallel with one another and with the edges of the paper. Your T-square is a precision instrument whose head is exactly at right angles to the blade, and whose blade is as nearly straight as quality will permit. On the other hand the sides of the drawing board may not be so precisely square, so if the head of the T-square is switched over from one side of the board to the other, the lines may not be truly parallel. Make a habit of placing the head of the T-square always against one side of the drawing board only. This may be the left side, but if you are left handed you may use the right



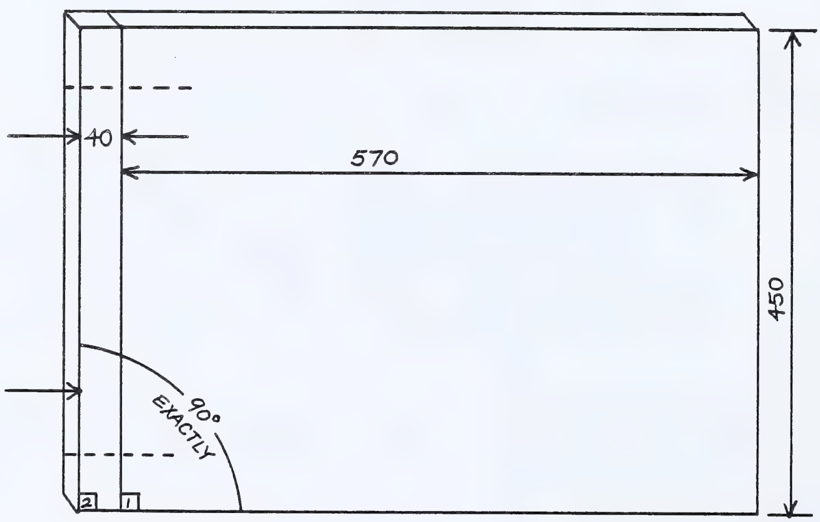
side. In either case always stay with the same side. Every time you use your instruments first wipe the board and T-square free of dust.

INSTRUCTIONS FOR MAKING A DRAWING BOARD

Since a professional drawing board is relatively expensive, drafting students may make their own drawing board for use in this course if they so desire. Plans for an inexpensive board are given below.

Materials Needed (Purchase locally.)

1. Plywood - 5 ply, about 20 mm thick, 450 mm × 570 mm
2. Clear Spruce or boxwood or basswood 40 mm × 20 mm × 450 mm
3. Finishing nails 60 mm long, glue, sandpaper

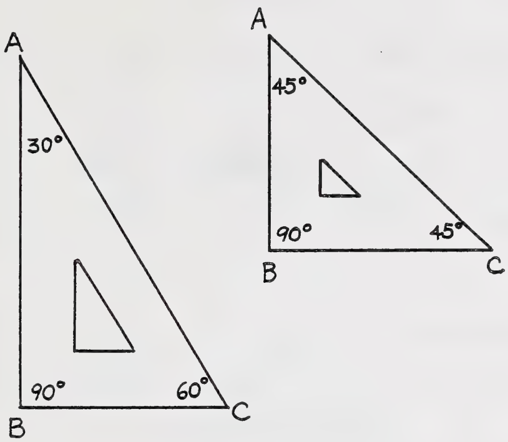


Saw and plane angles 1 and 2 to 90° exactly (use a good square) then glue and nail the slide strip on the left after the strip has been planed to size and has straight edges. Set in the heads of the finishing nails at least 3 mm before beginning to plane the edge square and smooth after gluing.

Use fine sandpaper, with the grain, to smooth the surface, then rub well in with the fingers one only very light coat of boiled linseed oil. Let it dry two or three days before using.

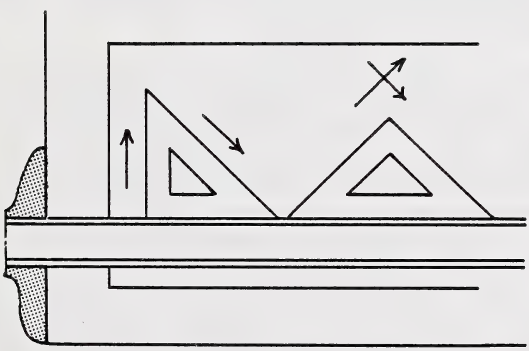
(Do not plane into the nail heads. Set in the nails first.)

4. Set Squares (Triangles)

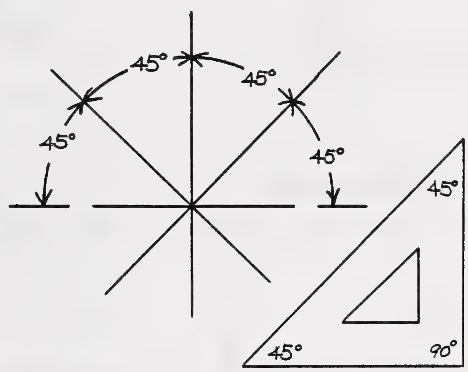


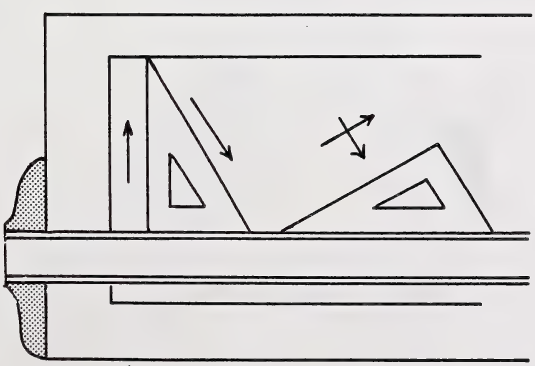
To construct vertical or sloping lines, the T-square is used in conjunction with one or more set squares. The set squares most commonly used are the 45° and the 60° - 30° set squares. Using these set squares singly or in combination, angles can be drawn in all the multiples of 15°. For all other angles the protractor is used.

The drawings below and on page 6 indicate how the set squares can be used to draw various angles in multiples of 15 degrees.

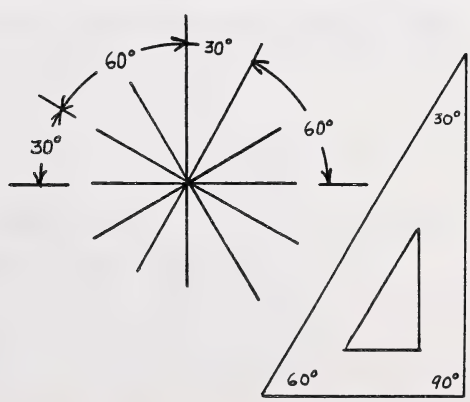


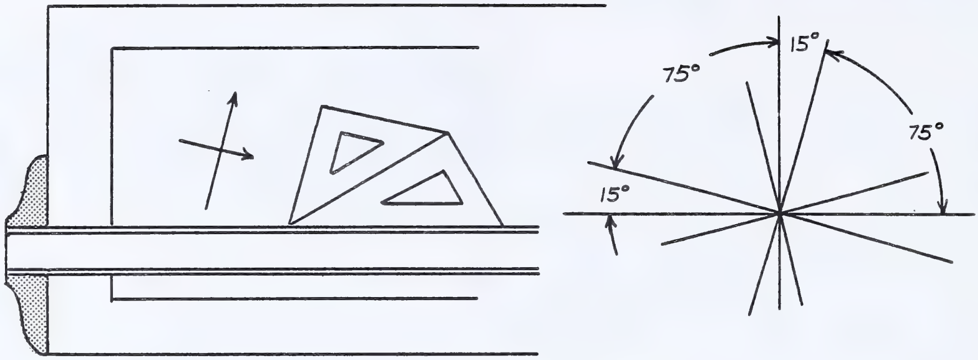
(a) THE 45° SET SQUARE





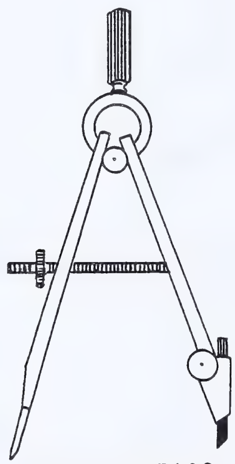
(b) THE 60° SET SQUARE





(C) THE SET SQUARE IN COMBINATION

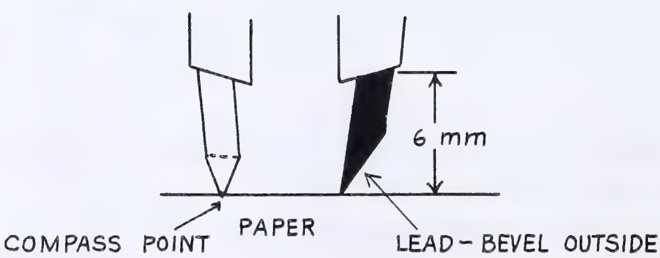
5. The Compass



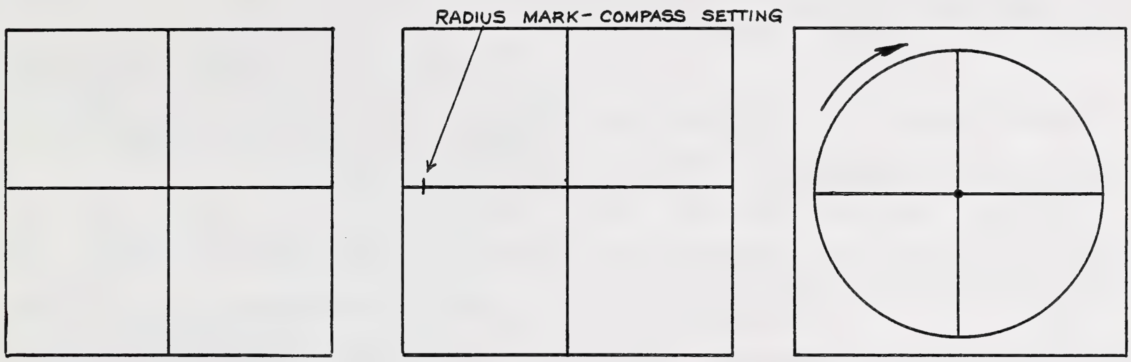
BOW COMPASS

The compass is used to draw circles and arcs. Although many styles and sizes of compasses are available, the spring bow compass with centre-screw attachment is in widespread use because of its rigidity in maintaining a setting. It is recommended that the student obtain the use of this type of instrument (preferably within a set of instruments).

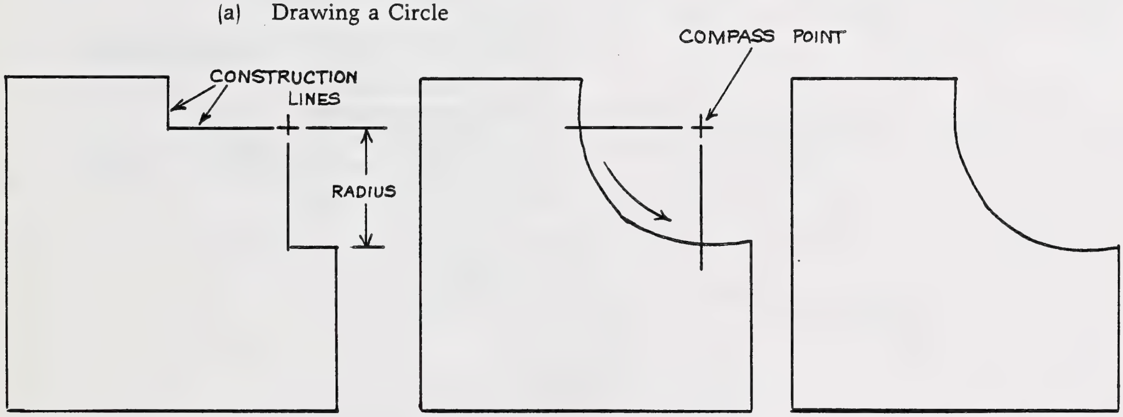
When drawing circles and arcs, shape the compass lead to a bevel point, as shown below. Use a lead that is one grade softer than the pencil lead used for object line work. This is necessary because pressure cannot be exerted on the compass to produce lines as dark as those made with a pencil. Adjust the lead so that it is slightly shorter than the compass point. After the centre of the arc or circle has been located, set the compass to the desired radius. Set the compass point at the centre mark. Hold the stem between the thumb and forefinger and draw the circle in a clockwise direction slightly tilting the compass in the direction the circle is being made. Complete the circle in one sweeping motion.



When arcs and straight lines tangent to them are required, it is easier to connect straight lines to an arc than to adjust the arc to the straight line. Hence, draw the arcs first. The illustrations below indicate how arcs and circles can be drawn.



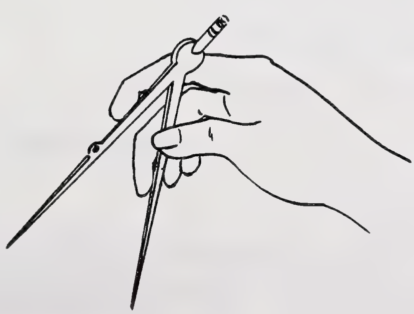
(a) Drawing a Circle



(b) Drawing an Arc

6. Dividers

This instrument is used for transferring or laying out measurements. Dividers have a steel pin inserted in each leg and come in a variety of sizes. Most compasses may be used as a divider by exchanging the lead for a steel pin insert.

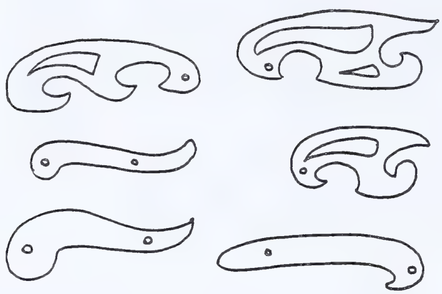


The dividers resemble compasses closely but instead of one leg ending in a pencil or pen point, both legs end in steel points.

7. Drawing Instruments

Instrument sets usually include compasses and dividers with extention attachments. For this course students could use a relatively inexpensive set.

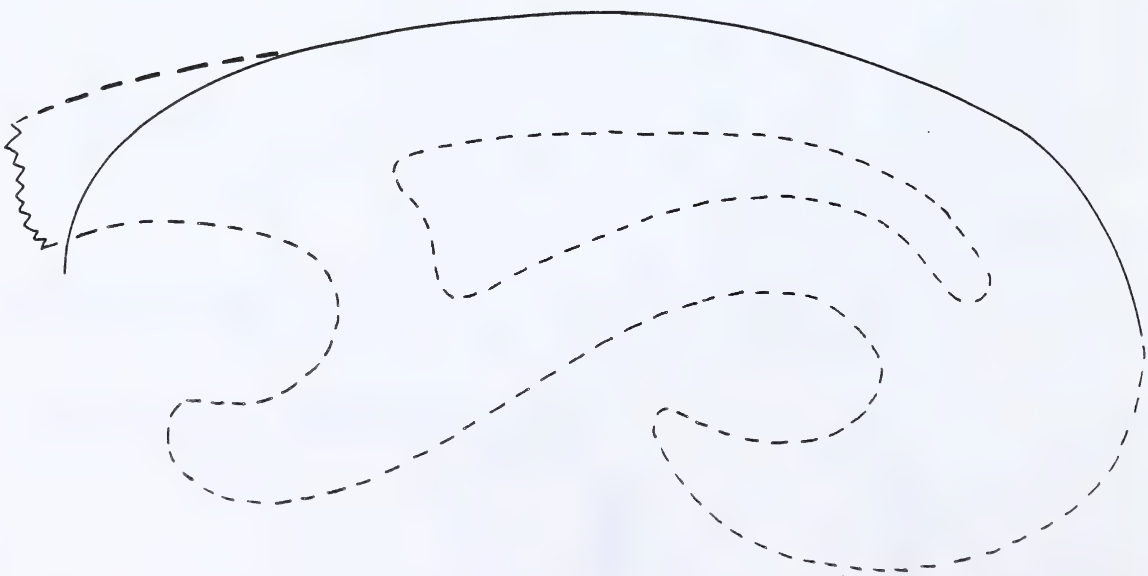
8. Irregular Curves



The irregular or french curve is used to lay out curvatures in which the radius is not constant. The patterns of these curves are based on the various combinations of ellipses, spirals and other mathematical curves.

The drawings to the left indicate several designs of irregular curves that are available.

To draw an irregular curve, first lay off a series of points to indicate the shape of the curve and sketch in a very light line connecting these points. Then, select a part of the french curve that fits a portion of the line as shown below. Arrange the curve so the curvature of the line increases. Care must be taken to ensure that the curve used matches the curved line to be drawn for some distance beyond the point where they appear to coincide. This procedure will help to eliminate abrupt breaks in the line.



9. Templates

In order to save time, many draftsmen use templates (prepared patterns) for drawing circles and arcs of small radii. Templates are also available for drawing standard squares, hexagons, triangles, and elliptical shapes. These include isometric circles sized in fractions or tapped drill sizes.

10. Erasers

In the process of making a drawing, the student will in all likelihood need to make certain corrections and changes which will involve erasing. Most pencil lines or marks can be easily erased with an ordinary soft pencil eraser. However the following points should be kept in mind.

(a) Hard or gritty erasers will damage the paper. Thus their use should be avoided.

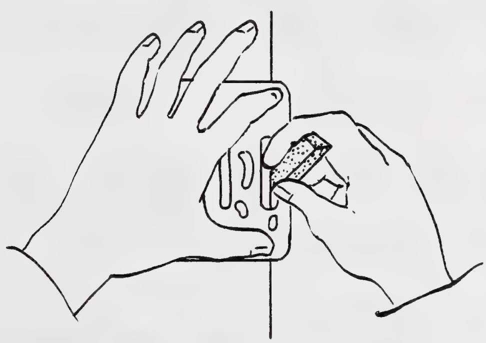
(b) Be sure that the eraser is clean before use. A simple way to clean an eraser is to rub it off on a piece of clean paper.

(c) Very often a considerable of erasing is necessary. If this occurs, a triangle or other hard, flat object may be placed under the paper. This provides for a smooth hard surface which will permit more effective erasing.

(d) Always take care not to tear the paper. Hold the paper firmly with your free hand near the area that requires erasing.

11. Erasing Shield

If erasing is necessary near lines which are to remain, the use of an erasing shield is very helpful. The erasing shield is a thin piece of flexible metal with slots of various sizes in it.



To use this shield:

(a) Select an opening that best fits the mark to be erased.

(b) Hold the shield firmly over the mark and erase through the shield.

(c) Clean the paper before continuing to draw.

12. Drafting Brushes

The drafting or dusting brush used by draftsmen may have natural or synthetic bristles. This tool is used to remove eraser particles and other dust from the drawing. A typical drafting brush is shown at the left. Do not use your hand to brush away any particles as smearing could occur.

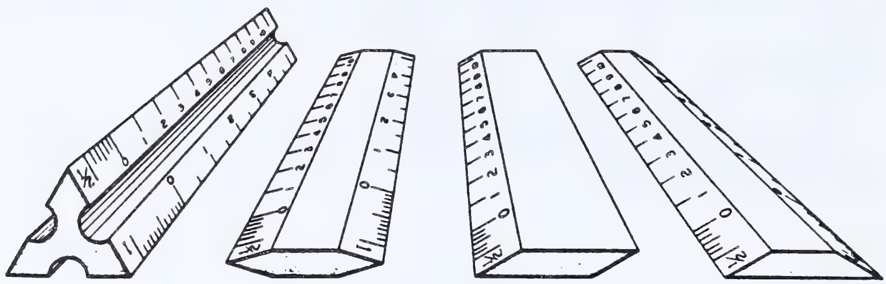
SCALES

When drawing an object on a sheet of paper it is not too often that the paper drawing represents the actual size of the object itself. The lines of most construction and engineering drawings require a scale factor to be used. In other words, the lines must be reduced or enlarged in order to fit the size of paper used. A map distance of 1000 m can be reduced to 1 m on paper if multiplied by a factor of 1/1000. The tiny screws in a watch can be portrayed on a drawing if their dimensions are multiplied by a factor of 20 or more.

The reduction or expansion of distances by mathematical calculations is very tedious. However, any required reduction or expansion can be made graphically employing a suitable graduated scale.

1. Types of Scales

There are many standard graduated scales available but four basic types are used.



Triangular 6 Scale Faces | Four – bevel 4 Scale Faces | Opposite – bevel 2 Scale Faces | Two – bevel 2 Scale Faces

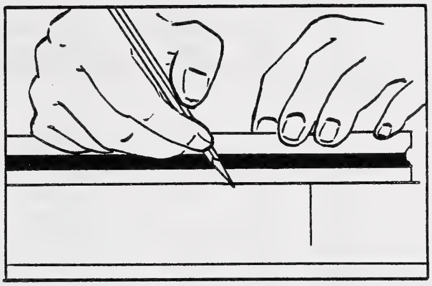
The triangular scale is popular because it provides six scale faces on one instrument, but draftsmen whose work is largely limited to only two or three scales prefer the flat-type scales. The four-bevel scale must be tipped to bring the scale edge against the paper. The opposite bevel scale lies flat in use and is easy to handle. The two bevel scale has a wide base but is somewhat difficult to pick up. Each scale shape is available in a wide variety of standard scale combinations.

DRAWING TO SCALE

The scales are graduated instruments used to make measurements along a straight line. Although straight, the scales are not straight-edges and are not to be used to rule lines. Hence, they are not called rulers.

On a drawing, the location of any particular line will usually have to be found by measuring. Lines of measured length are first drawn lightly and overlong using the T-square or triangles. Suppose we want to draw a horizontal line 25 mm down from the top of the drawing paper. Place the T-square and triangle on the paper as previously instructed. Now lay your scale measure along the vertical edge of the triangle. Draw a short, light, HORIZONTAL dash after placing the point of the pencil at the mark on the scale which is 25 mm from the paper's edge. The dash should be horizontal so that it will become part of the horizontal line when it is drawn. Do not make a heavy dot or an X since these measuring marks will stick out from the finished drawing. Measurement marks for vertical lines should be short vertical strokes.

Note that the scale is applied directly to the paper. Never use dividers to transfer from scale to paper.



COMMON SCALES IN USE

A scale indicates the ratio between the actual length of lines in a drawing and the true measurements of the object drawn. The scale of a drawing may be expressed in one of the three ways (the first digit in the ratio always refers to the scale drawing, the second of the true size of the object).

1. **Full Size** (1:1)

Full scale indicates that the object is drawn at its actual size, as in the size of various mechanical parts.

2. **Enlargement Scale** (eg. 2:1, 5:1, 10:1, etc.)

This means that the object (such as a small watch part) is drawn larger than its actual size. A 2:1 scale shows lengths twice their true size lengths.

3. **Reduction Scale** (e.g. 1:2, 1:5, 1:10, etc.)

This represents the reduction in size of objects too large to be shown true size on a drawing.

4. **Recommended Scales**

The Canadian Government Standards Branch (CGSB) standard 88-GP-20M specifies scales and ratios recommended for use on engineering drawings, on architectural and construction drawings, and for surveying and mapping purposes. The chart on the following page indicates these recommended ratios.

SCALES (RATIOS) FOR USE WITH THE METRIC (SI) SYSTEM:	ENGINEERING	ARCHITECTURAL & CONSTRUCTION	SURVEYING & MAPPING	REPLACING THE FORMER IMPERIAL SCALES:
REDUCTION				
1 : 1 000 000			x	
1: 500 000			x	
1: 250 000*			x	
1: 200 000			x	
1: 100 000	x		x	1'' = 8 000' and 1'' = 10 000'
1: 50 000	x		x	1'' = 4 000' and 1'' = 5 000'
1: 25 000*			x	
1: 20 000			x	1'' = 2 000'
1: 10 000	x		x	1'' = 800' and 1 '' = 1 000'
1: 5 000	x		x	1'' = 400' and 1'' = 500'
1: 2 000	x	x	x	1'' = 200'
1: 1 000	x	x	x	1'' = 80' and 1'' = 100'
1: 500	x	x	x	1'' = 40' and 1'' = 50'
1: 200	x	x	x	1'' = 20' or 1/16'' = 1'-0''
1: 100	x	x	x	1'' = 10' or 1/8'' = 1'-0'' and 3/32'' = 1'-0''
1: 50	x	x	x	1/4'' = 1' -0'' and 3/8'' = 1' -0'' and 3/16'' = 1' -0''
1: 20	x	x		1/2'' = 1' -0'' and 3/4'' = 1' -0''
1: 10	x	x		1'' = 1' -0'' and 1 1/2'' = 1' -0''
1: 5	x	x		3'' = 1' -0''
1: 2	x			
FULL SCALE				
1 : 1	x	x		
ENLARGEMENT				
2 : 1	x			
5 : 1	x			
10 : 1	x			
20 : 1	x			4 : 1
50 : 1	x			8: 1
100 : 1	x			

Note: * = the 1 : 250 000 and 1 : 25 000 scales are included only because of the large number of such maps in existence; these scales will be maintained.
x = indicates usage of a particular scale for the purpose shown.

5. Preferred Scales for Building Drawings

TYPE OF DRAWING:	RECOMMENDED SCALES	USE:
Block Plan	1 : 2 000 1 : 1 000 1 : 500	To locate the site within the general district.
Site Plan	1 : 500 1 : 200	To locate building work, including services and site works, on the site.
Sketch Plans General Location Drawings	1 : 200 1 : 100 1 : 50	To show the over-all design of the building. To indicate the juxtaposition of rooms and spaces, and to locate the position of components and assemblies.
Special Area Location Dwgs.	1 : 50 1 : 20	To show the detailed location of components or assemblies in complex areas.
Construction Details	1 : 20 1 : 10 1 : 5 1 : 1	To show the interface of two or more components or assemblies for construction purposes.
Range Drawings	1 : 100 1 : 50 1 : 20	To show in schedule form, the range of specific components and assemblies to be used in the project.
Component and Assembly Details	1 : 10 1 : 5 1 : 1	To show precise information of components and assemblies for workshop manufacture.

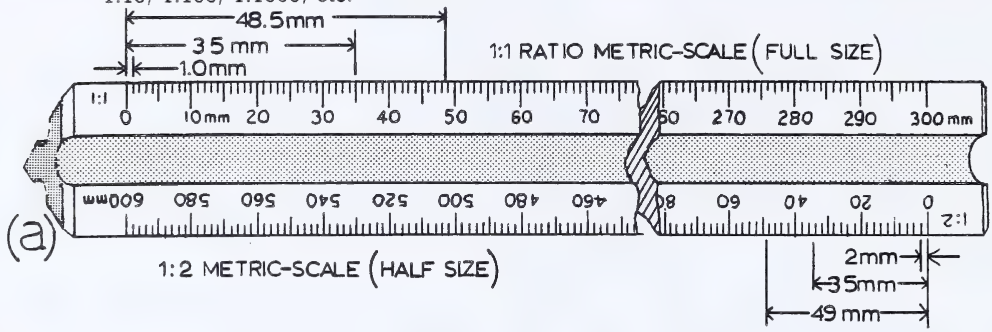
The scale used in drawing should be stated in the title panel of each drawing sheet, e.g., SCALE 1:1000. Full scale drawings are denoted by SCALE 1:1. The notation NOT TO SCALE or N.T.S. may be used on drawings which are not drawn to any particular scale.

6. Using the Metric Scale

The metric scale is used when the metre is the standard for linear measurement. Metric scales are available in flat and triangular styles with a variety of scale graduations. The simplicity of the metric system is reflected by the ease with which metric ratios can be manipulated. The triangular scale illustrated on page 14 has one full-size scale and five reduced-size scales, all fully divided. By means of these scales a drawing can be made full size, enlarged size, or reduced size.

FULL SIZE

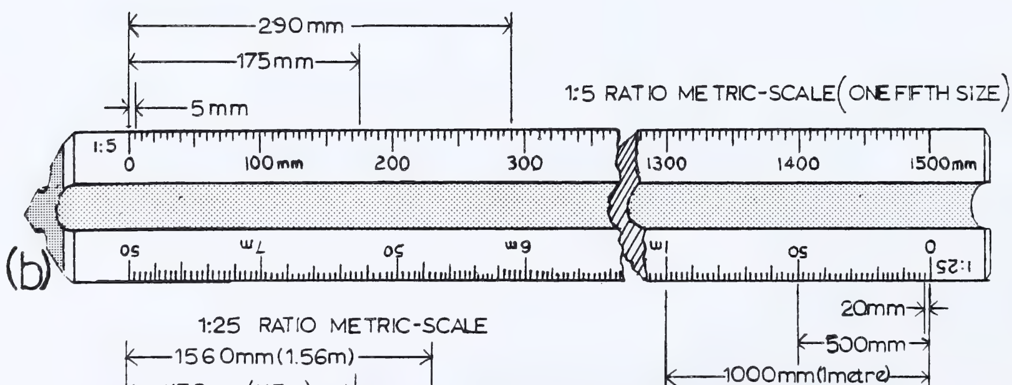
The 1:1 scale is full size and each division is 1 mm in width with the numbering of the calibrations in 10 mm intervals. This same scale is also convenient for the ratios of 1:10, 1:100, 1:1000, etc.

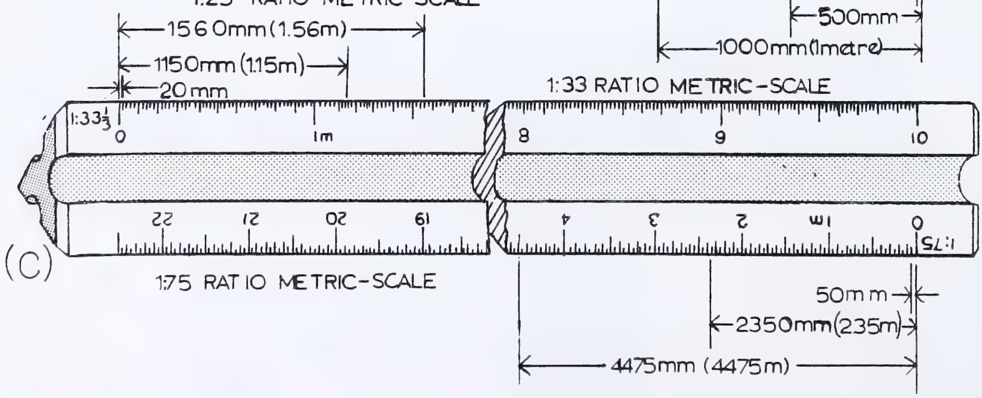


HALF SIZE

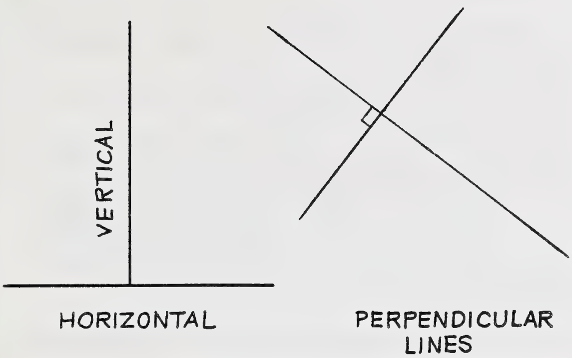
The 1:2 scale is one-half size and each division equals 2 mm with the calibration numbering at 20 unit intervals. This scale is convenient for ratios of 1:20, 1:200, 1:2000, etc.

The remaining four scales on the triangular metric scale include the typical scale ratios of 1:5, 1:25, 1:33⅓, and 1:75 as illustrated below. The ratios may also be enlarged or reduced as desired by multiplying or dividing by a factor of 10.





DRAWING HORIZONTAL AND VERTICAL LINES



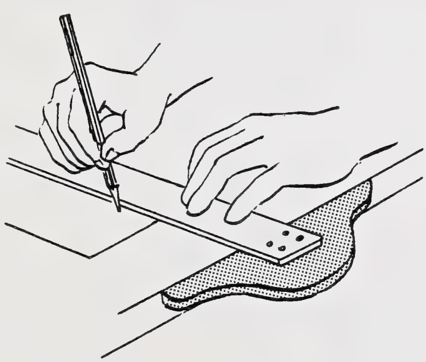
Horizontal lines are lines that run from side to side across the paper.

Vertical lines line up and down on the paper.

Vertical and horizontal lines meet each other at right angles. Lines which meet at right angles are said to be perpendicular to each other.

1. Horizontal Lines

Horizontal lines are drawn using the UPPER edge of the T-square. The head of the T-square is always held firmly against the same edge of the drawing board. The place where the line is to be drawn having been marked with a light horizontal dash, proceed as follows:

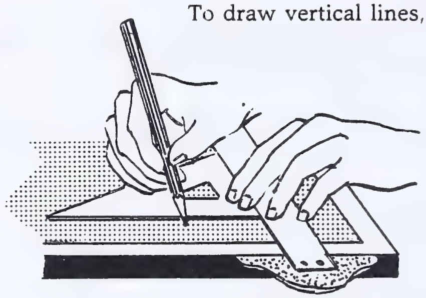


(a) Place the pencil point on this dash.
(b) Slide the T-square up to the pencil point.
(c) Draw the line from left to right, sliding the fingers along the blade of the T-square as you draw.

NOTE: The pencil is placed in position on the dash first and then the T-square is brought up to the pencil. Otherwise, if the reverse procedure were used, the exact allowance for the pencil width would not be made.

(d) Hold the pencil so it is tipped in the direction that the hand moves and slightly outward as shown to the left. The point of the pencil must be against the blade as it touches the paper. Keep the pencil in the same position throughout to make sure that the line will be perfectly straight.
(e) Apply uniform pressure and roll the pencil slightly between the thumb and fingers as the line is drawn.
(f) Do NOT track the pencil back and forth.

2. Vertical Lines

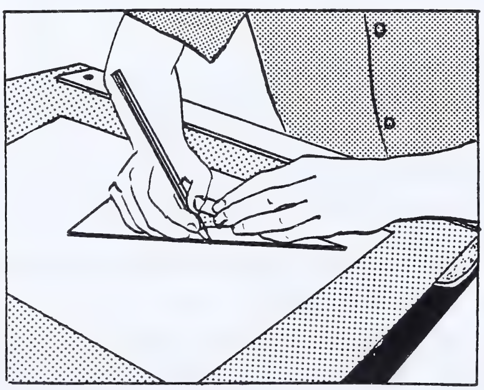


To draw vertical lines, proceed as follows:

(a) Use either the 45° or 30°-60° triangle along with the T-square.
(b) Place the T-square so that the blade is below the line to be drawn.
(c) Hold the pencil point on the vertical dash which marks the position of the vertical line.
(d) Keep one of the perpendicular sides of the triangle flush with the top of the T-square blade and slide the triangle along until it touches the pencil point.
(e) With the right hand hold the pencil firmly between the thumb and first two fingers approximately 25 mm from the pencil point.
(f) Lean the pencil in the direction of the line at an angle of about 60° to the drawing paper.
(g) Draw the line from a point near the T-square up toward the top of the triangle letting the fingers slide along the triangle. Use the other hand to keep the triangle snug against the T-square, and the T-square head snug against the side of the drawing board.

NOTE: The procedure outlined above should be reversed if the student is left handed.

3. Slanted Lines



To draw slanted lines you must first locate two points on the line. Any edge of either triangle (or the edge of the T-square for very long lines) may then be used as a straightedge to connect the two points as shown to the left.

DRAFTING PAPER

For the purposes of this course, students will be supplied and expected to submit all drawings on white sheets of paper. These sheets are enclosed at the back of Lessons 14 and 15.

All drawings are to have a border on all four sides plus a title block situated along the bottom long side. The title block and the information it contains may vary with the company (or school) but they usually include: title, drawing number, name of company or school, scale used, name of draftsmen, date drawn, sheet number, name of checker or supervisor. An example of how the drawing paper should be bordered and titled is shown on the next page.

PRINT SCHOOL OR COMPANY NAME

TITLE

NAME :

SCALE :

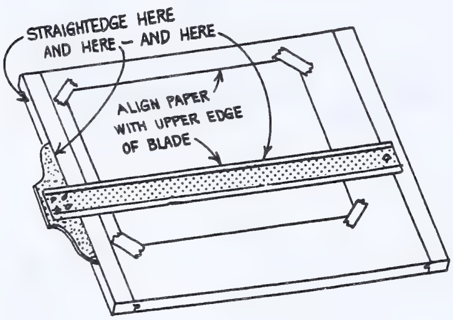
DRAWING NO.

CHECKED BY:

DATE :

Note that some of the drawing sheets provided with this course have borders and title strips printed on them. For certain exercises you may use these sheets instead of drawing borders and title strips on blank sheets. If you run out of sheets with printed borders and title strips, you will have to draw them on the blank sheets when you do the required exercises.

POSITIONING THE DRAWING SHEET



To position the drawing sheet on the drafting board, line up the top or bottom edge of the paper with the top horizontal edge of the T-square. To fasten the sheet, use drafting tape (masking tape) or spring clips on each corner. Either of these methods allow for frequent fastening and removal of the sheet without causing damage to it. It is important to remember, however, that when refastening a partially completed drawing, the lines rather than the paper edge should be used for alignment. This practice helps to prevent the duplicating of errors.

1. Fastening Drawing Paper on the Drawing Board

Use the drawing paper supplied with the lessons. If your board has a surface which is at all rough it is a good idea to line the surface with a layer or two of smooth paper covering the surface of the board. Attach the lining paper with masking tape at the top.

We now want to place the drawing paper on the board so that

(a) it is perfectly flat when attached in place
(b) it is lined up so that the drawing will appear straight on the page.

This is another of those operations which may seem to be so simple that no explanation is required. But unless the correct method is followed the paper will not lie flat and square on the board and trouble will result when using the T-square.

The edges of the paper may not be cut exactly square so we shall line up the top edge and disregard any discrepancies in the others. Proceed as follows, after wiping the board and T-square free of dust. (Wipe the top edge of the T-square to remove lead particles.)

(a) Place the sheet in the upper left portion of the drawing board about 150 mm from the left edge and 100 or 125 mm below the top. With the paper in this region you will have arm freedom, and the head of the T-square, being close at hand, can be readily kept firmly against the edge of the board.

(b) Fasten the upper-left corner of the paper only. The best way to do this is to use a small piece of masking tape about 12 × 20 mm. Do not use cellophane tape as it cannot be removed from the paper again cleanly.

(c) With the head of the T-square held firmly against the edge of the board, line the top edge of the paper up with the upper edge of the T-square.

(d) With one hand, hold the paper firmly in position; with the other hand, slide the T-square down toward the centre of the sheet. Hold it firmly while changing hands to make one hand free.

(e) With the palm of the hand, stroke the paper snugly to the board working from the upper-left corner to the lower-right corner. Fasten the lower-right corner.

(f) Smooth the paper firmly toward the upper-right corner and fasten.

(g) Check to see that the upper edge of the paper still lines up with the T-square.

(h) Stroke the paper from the centre toward the lower-left corner and fasten.

LAYING OUT A DRAWING SHEET

Enough drawing sheets are supplied so that you can complete the course. The sheets measure 216 mm × 280 mm. You shall make the drawings with a 204 mm × 254 mm border. It is strongly recommended you make at least one drawing showing borders and title block using a supplied blank sheet of paper. This you will do later in this lesson.

To prepare a blank sheet ready for placing a drawing requires the following steps.

(a) Fasten the paper on the drawing board as described earlier in this lesson. Keep it toward the upper left of the board well away from the ledge at the bottom of the board.
(b) Find the center of the sheet.
(c) Rule the 204 × 254 mm border.
(d) Rule a title block at the bottom the the sheet 11 mm wide above the border. (The sheet is to be placed lengthwise on the drawing board.)

Do all ruling very lightly with a 4H pencil.

1. Finding the Center

Place the blade of your T-square across the sheet with the upper edge from the top left corner of the paper to the bottom right corner. Rule a line near the middle of this distance. Then move the blade and place it from bottom left to top right corner of the paper. Rule a short line which crosses the first line. Where the lines cross is the centre of your drawing paper.

2. Ruling the Border

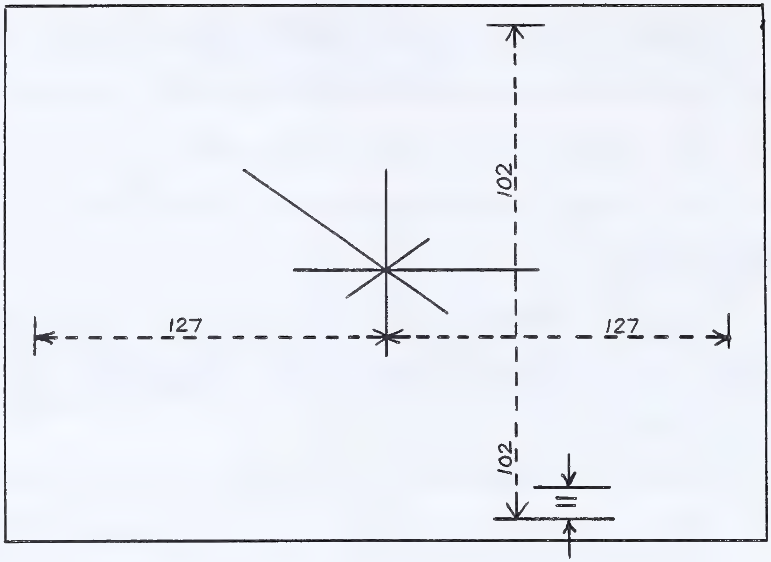
With T-square draw a horizontal line about 30 mm long through the center. Place a triangle on the T-square and draw a short vertical line through the center.

Measure 102 mm up from, and 102 mm down from the horizontal line to locate your horizontal borders.

Measure 11 mm up from the bottom border to give you the top line of the title block.

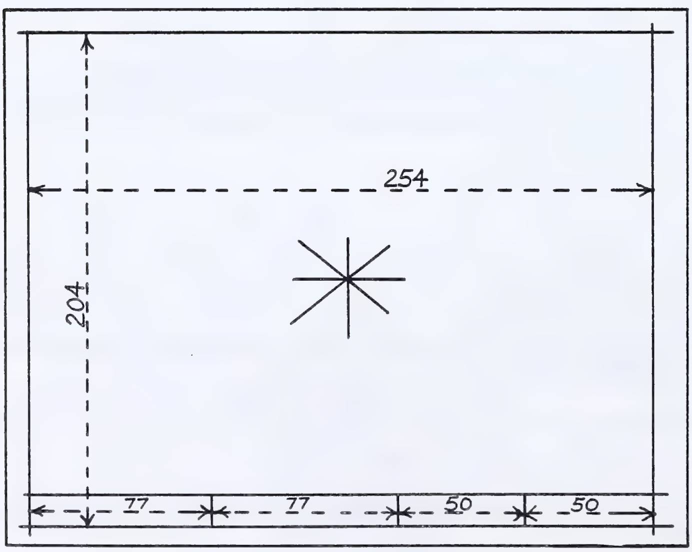
Measure 127 mm to left and right of the vertical line to locate your vertical borders.

Your sheet will now show the construction lines and measurement strokes illustrated on the next page. Of course the dimensions on our illustration will not appear on your sheet.



3. Partitioning the Title Block and Ruling the Borders

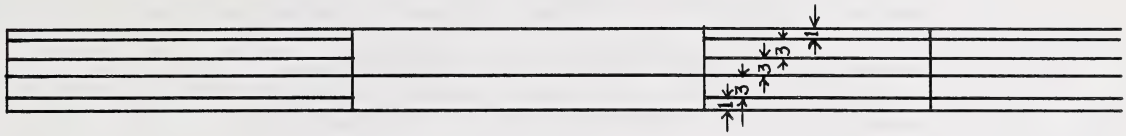
Measure distances 77 mm, 77 mm, and 50 mm apart starting from the left border, within your title block. Now use the T-square to draw all the horizontal lines required and use a T-square and triangle to draw all the vertical lines required. You should end up with the lines lightly drawn as shown below.



The light lines should overlap slightly at the corners. Leave things that way until the drawing is entirely completed. Then the required border lines will be heavied up. The heavy lines must MEET EXACTLY at the corners. No overlaps or gaps are acceptable.

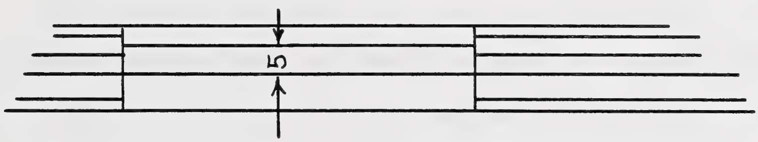
4. Ruling the Title Block

Now rule the guide lines for lettering in the title block as shown below.



Rule the horizontal lines in section 1, and sections 3 and 4 with the single setting of the T-square.

Finally, draw a second guide line in section 2, 5 mm above the first.



The drawing sheet has now been provided with the light outlines of a 204 × 254 mm border with an 11 mm title block at the bottom divided into 77, 77, 50, and 50 mm sections ruled with guide lines for lettering. Such a sheet is called a plate.

Complete the following exercises and submit them for correction.

EXERCISE 1 Answer 'True or False' in the space to the left of each statement.

_______ 1. If the hand is used instead of a cloth or brush for wiping away particles left from erasing, the paper will smear and become dirty due to grease and moisture on the skin.

_______ 2. An ink eraser will destroy the smooth surface of the paper even though it erases a line quickly.

_______ 3. The pencil should not be sharpened on the lettered end because the letter helps in selecting the proper pencil after all the pencils have been sharpened.

_______ 4. In making a straight line, the straight edge should be brought to the desired point and then the pencil is placed against it.

_______ 5. The pencil may be moved back and forth when ruling lines.

_______ 6. When ruling, the head of the T-square may be changed from one side of the drawing board to the other side.

_______ 7. A large dot is the best way to mark the location of a line.

_______ 8. In order to draw an angle of 75° you would use the T-square plus two 30°-60° set squares in combination.

_______ 9. When drawing a circle, the stem of the bow compass is held between the thumb and the forefinger.

_______ 10. Irregular or french curves are used to layout arcs or circles.

_______ 11. The four-bevel scale can be used to rule lines.

_______ 12. N.T.S. means the drawing is to be full scale.

EXERCISE 2 Fill in each blank with the correct letter or word.

1. Pencils used in drafting are _________ and those used by artists are _________.
2. Soft pencils are lettered with ____________ and a number while hard pencils are lettered with ____________ and a number on each end.
3. A ____________ grade of sandpaper should be used for sharpening a pencil lead.
4. Horizontal lines are drawn with the _______________ edge of the T-square only.
5. Dividers closely resemble ____________________________________.
6. The triangular scale has _________ scale faces while the opposite-bevel scale has ____________ scale faces.
7. A 1:10 scale could be used in architecture and construction but not in ____.

EXERCISE 3

1. Why should you sharpen the pencil away from your drawing?

____

____

2. Why should you wipe the instruments each time you prepare to work?

____

____

3. Why must you carefully smooth the paper before fastening it?

____

____

4. Why should you use masking tape in fastening rather than cellophane tape?

5. Why should you roll the pencil when drawing a straight line?

6. Why is the triangular scale popular with draftsmen?

7. Why should vertical lines be drawn with a triangle rather than a T-square?

EXERCISE 4 Think carefully before answering the following questions.

1. Why are enlargement scales (such as 10:1 and 50:1) not used in surveying and mapping? What kind of scales are used?

2. In drawing a partial view of a wooden building where two walls join, a scale of 1:20 is used. Is this scale satisfactory? List one supporting reason for your answer.

EXERCISE 5

Using the following scale measurements indicate the actual length. The triangular scales on page 14 may be used to help you answer this exercise.

1. measurement of 35 mm on a 1:1 scale ____________________
2. measurement of 269.5 mm on a 1:1 scale ____________________
3. measurement of 50 mm on a 1:2 scale ____________________
4. measurement of 522 mm on a 1:2 scale ____________________
5. measurement of 270 mm on a 1:5 scale ____________________
6. measurement of 1000 mm on a 1:25 scale ____________________
7. measurement of 4.475 m on a 1:75 scale ____________________
8. measurement of 8.8 m on a 1:250 scale ____________________

EXERCISE 6

Using a blank sheet of white paper enclosed at the back of this lesson, layout a drawing sheet according to the instructions on pages 16 to 21 of this lesson. Submit it for evaluation. Your drafting plate should include the following: centre of the plate, the borders, the title block, plus guide lines for the title block. Using capital letters label the title block with the following information.

1. School name section should be labelled ALBERTA CORRESPONDENCE SCHOOL.
2. Drawing No. section should be labelled DRAWING NO. 1
3. Title section should be labelled DRAWING PLATE.
4. Name Section should be labelled with your name (e.g. JOHN X. JONES).
5. Checked by section should be labelled CHECKED BY:
6. Scale section should be labeled NOT TO SCALE
7. Date section should be labeled in metric with the date of your completed plate (e.g. 1984-02-21).

END OF LESSON 14

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

____

(If label is missing
or incorrect)

File Number

____

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received:

____

Lesson Recorded ________

Student's Questions and Comments

Apply Lesson Label Here

Name ______

Address ______

Postal Code ______

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____

Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

PLANNING AND DESIGN II

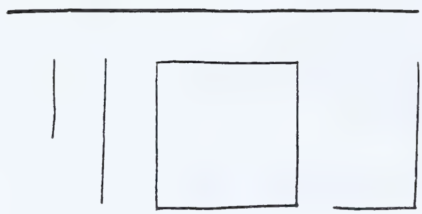
Sketching straight lines
Sketching angles
Views of a working drawing-orthographic projection
Sketching a working drawing in orthographic projection
Lines used in drafting
Lettering
Steps in making a working drawing
Dimensioning a working drawing
Centering or blocking in a plate
Keeping the drawing clean

SKETCHING STRAIGHT LINES

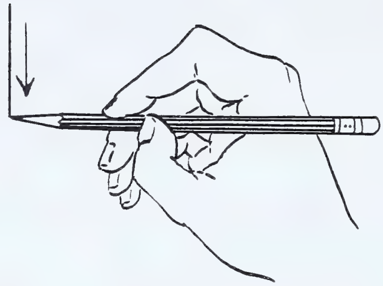
Before one can make an accurate drawing a sketch is necessary. It is much quicker and more convenient to sketch freehand than to use instruments for drawing straight lines and circles. However a sketch which does not show straight edges with reasonably straight lines is of little use. To sketch good straight lines hold the pencil lightly about 50 mm from the point. Make a mental note of where you want to stop your line before you begin to draw. Then run your hand along carrying the pencil in a single fairly fast relaxed movement along the paper to this point. Avoid lifting the pencil from the paper before you reach the end of the line. Draw each line with a SINGLE, clean stroke, not a succession of fuzzy strokes. To maintain the conical point on the pencil, occassionally rotate the pencil in your fingers as you sketch.

CHECK LIST OF SKETCHING PROCEDURES

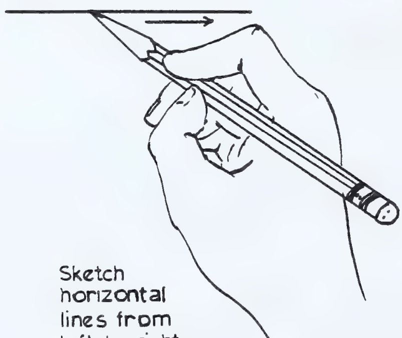
1. See that the pencil is kept sharpened to a long cone-shaped point.
2. Hold the pencil lightly, 50 mm or more from the point.
3. Lightly locate the points between which the straight line is to be drawn. Start at one point and keep your eye on the other. Then draw your hand steadily across the paper. If the line is wavy erase it and redraw it.
4. Use the eraser as little as possible. Try to get the line right the first time.
5. Sketch horizontal lines from left to right; vertical lines from the top downward. Usually lines at a slant are also sketched from the top downward.
6. Rotate the pencil in your fingers as you sketch.



Sketched lines should meet squarely.

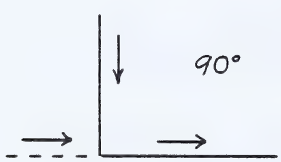


Sketch vertical lines from the top downward.

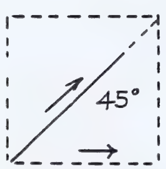


Sketch horizontal lines from left to right.

SKETCHING ANGLES

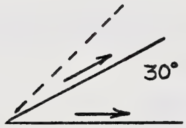


An angle of 90° with the horizontal is easy to sketch. Just draw a down stroke followed by a stroke to one side or the other.

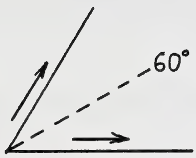


Draw a 45° angle by mentally considering a square. The diagonal makes a 45° angle with either side.

To draw a 30° angle estimate 2/3 of a 45° angle.



If you practice 30° angles, you can make a 60° angle by estimating double the size of the 30° angle.

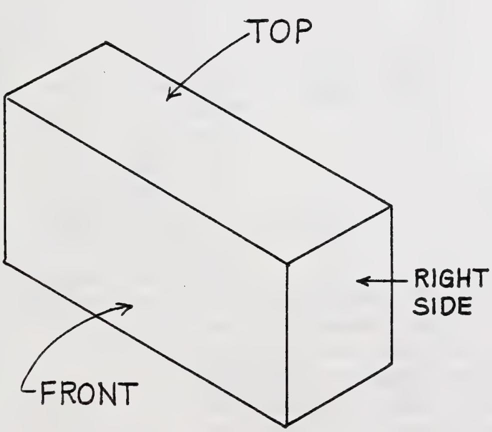


Note the direction of pencil strokes which are shown by arrows.

VIEWS OF A WORKING DRAWING - ORTHOGRAPHIC PROJECTION

When we look at a solid object we can not of course see all sides of it at once. Consider the simplest type of object, a rectangular block. If we turn the block slightly and place it below eye level the most we shall be able to see is one end, one side, and the top. Furthermore, the angles and lengths will not appear in their true sizes.

A pictorial drawing is a drawing which shows an object as it looks to the eye. Such a drawing is not suitable for use in supplying the information required to make an object. It is the draftsman's job to create from the object or a pictorial drawing of the object, a set of working drawings which will provide all the information required to enable the workman to construct the object.



The faces are named as shown above.

The working drawing separates the object into faces. Each face is shown in its true shape and size. Also the faces are shown on the drawing in their correct relationship to one another. The method used to achieve this is called orthographic projection.

Using this method each view shows a face as it appears from a point directly in front of it. The front view is drawn as it appears when it is straight in front of the observer so that the line of sight between the surface observed and the eye is at right angles (perpendicular) to the surface. The top view is also drawn looking squarely at it from a point directly above. The side views likewise are drawn as if seen from points directly in front of the sides.

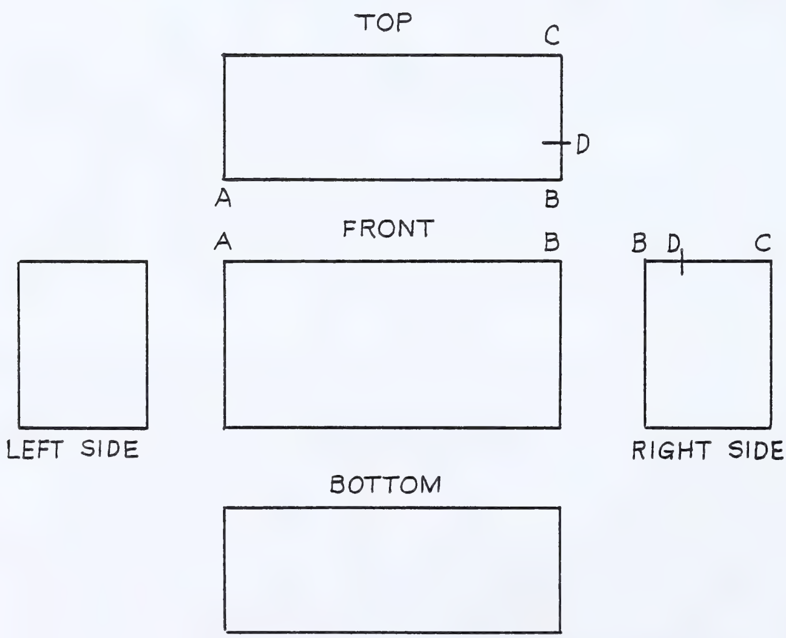
Consider the rectangular block. It has six sides or faces. So as to keep track of what we are talking about we shall give each face a name. The name we give to a particular face depends on the side of the block we choose to stand it on. To get the best

picture we stand the block so that one of the largest faces is facing us. So we stand the block up as shown in the drawing at the bottom of page 3.

The block has six faces but we can see only three of them. The faces which are hidden are the back, the bottom, and the left side.

An orthographic drawing consists of a separate outline for each face. But it is not necessary to draw all six faces in order to portray all of the details of the object. Usually three faces are drawn, but sometimes two or even one is sufficient. The separate outlines are arranged in a special way. Suppose we were to draw the top, front, bottom and side views of the rectangular block. In the center we put the front view. In line with this on the right we put the right side view. Also in line on the left we put the left side view.

Still in line but vertically above the front view we put the top view. Likewise the bottom view is in line vertically below the front view.



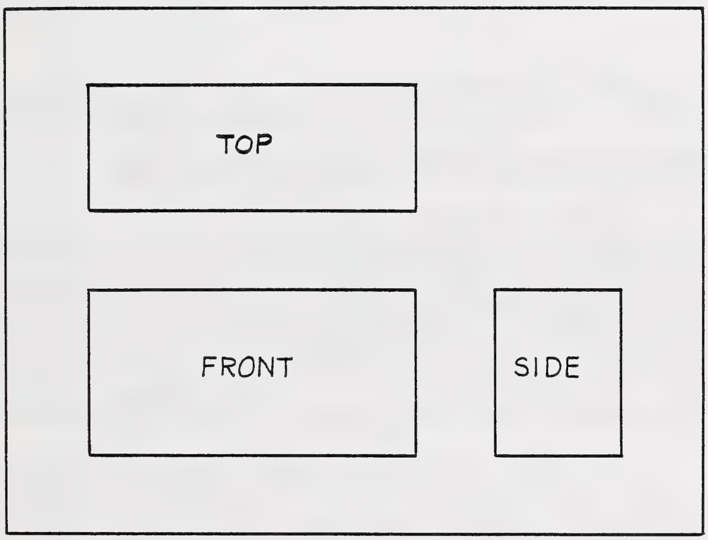
You must realize that each line in the drawing represents an edge of the block. There are however more lines in the drawing than there are edges of the block. This is because each edge is shown on two views. It is very important to understand which two lines represent the same edge and which end of any line in one view corresponds to the same end in the other view in which it appears. Thus in the drawing the edge AB in the front view is the same edge as AB in the top view. Also, if we have a point D on the right side view which is a quarter of the way from B to C, it will also appear at D in the top view, nearer to B than to C.

If we measure to the RIGHT on the side view we must measure UP on the top view.

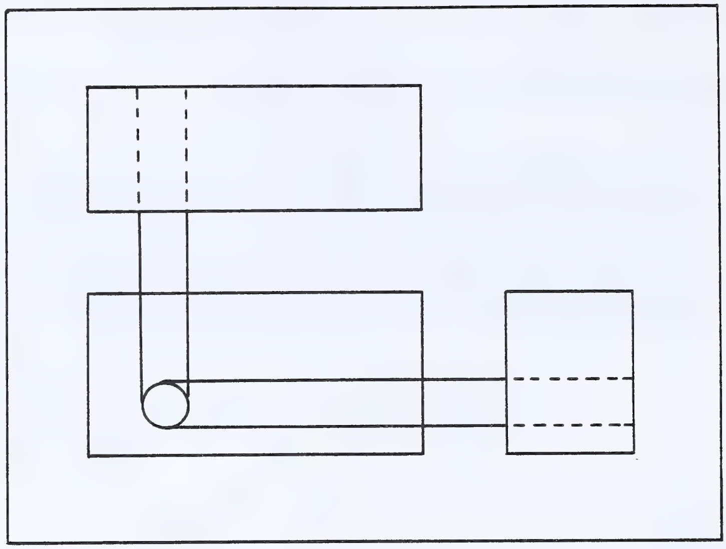
The corner B appears in three views in such a way that all points B are next to one another. Also each of the two lines which represent one edge are alongside each other in adjacent views. (Adjacent views are those next to each other.)

Now for most objects all six views are not needed since opposite faces are alike or nearly so. Usually, at most, three adjacent faces are sufficient. In this case the front, top, and right side views may be used, and they are placed on the drawing like this:

(The faces shown are NOT named on the working drawing. Which way up the finished object will rest is of no interest to the workman.)



Now suppose a fifteen millimetre hole was drilled through the front of the block. It would of course come out at the back. But it would not be possible to see the hole if the block were facing end on. Nor could you see the hole if looking at the top of the object. The draftsman must draw the views as if he had X-ray eyes and could see ALL edges below the surface of any face. These edges are drawn with hidden-edge lines and the orthographic drawing looks as shown on the next page.



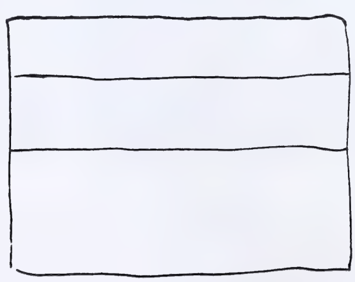
(Note how construction lines were used to assist in lining up the hidden-edge lines. When a drawing board and instruments are used these might not be necessary.)

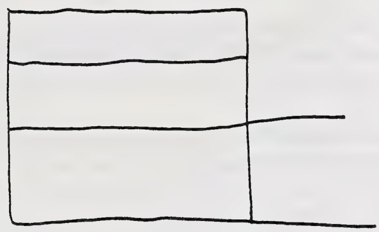
SKETCHING A WORKING DRAWING IN ORTHOGRAPHIC PROJECTION

You have learned that a free-hand sketch must first be made before any working drawing is made with instruments. The sketch must be complete. It must contain all the information which is required to be placed on the final drawing to enable the workman to construct the object. All the views which are required must be in the sketch and placed in correct relation to each other. Everything should be roughly in proportion or to scale. That is, if the length of a block is 100 mm and its width is 50 mm, the rectangle should appear to be twice as long as it is wide. But do not make any measurements -- estimate the lengths in proportion to each other by eye.

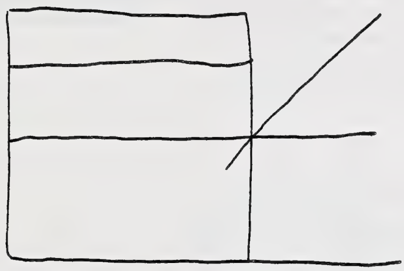
Working drawings are in orthographic projection. Projection is done by extending construction lines from one view to another. For example, let us consider a working drawing for a rectangular block which is 100 mm × 50 mm × 25 mm.

First we sketch the front view which will be the 100 × 50 mm surface. It will be about twice as long as wide. Now the top view will show a 100 × 50 mm surface. To obtain the 100 mm length we simply extend the end lines upwards, then draw two more horizontal lines the right distance apart to represent 25 mm. Our drawings should now look like this:

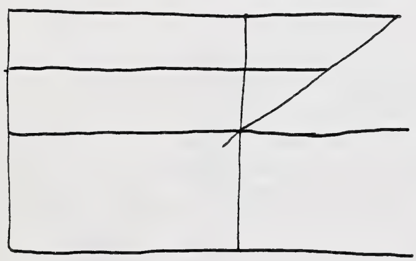




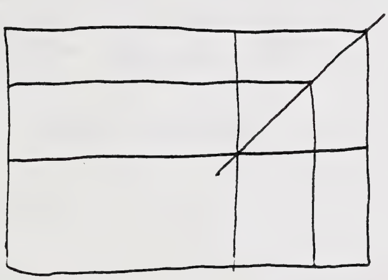
The right side view must now be added. The side of the block is a 50 × 25 mm rectangle. This rectangle is completed in the sketch simply by extending the lines we already have in the proper way. The 50 mm length is obtained by extending from the front view as shown to the left.



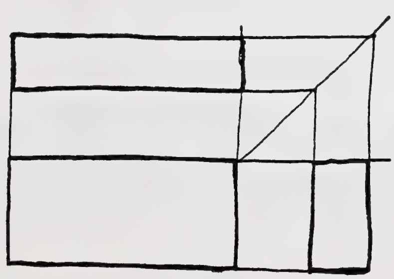
Now we draw a line at 45° from the top right corner of the front view as shown. Then we just extend ALL the horizontal lines in the top view to meet this line.



Finally we drop vertical lines down from each point where these lines meet the 45° line and our side view is complete.

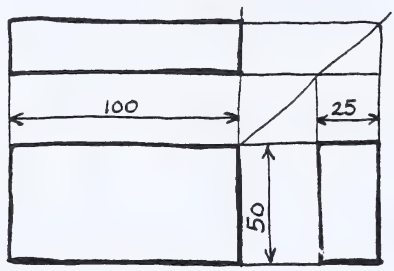


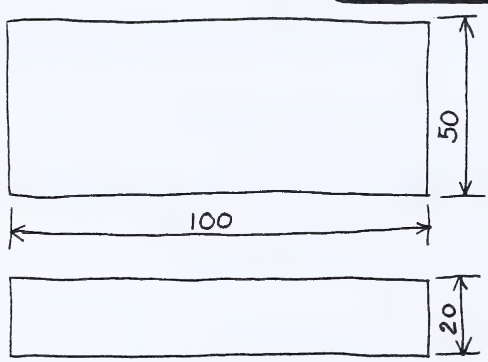
If all the construction lines have been made very light we can now arrive at the sketch of the three views by heavying up the lines which actually show the three views of the block.



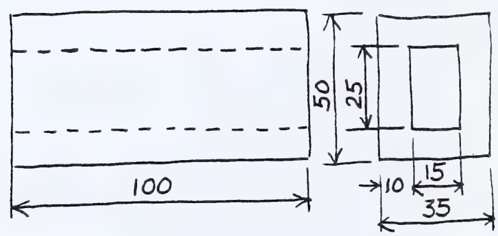
In problems as simple as this you will not need to use construction lines at all, or you can made them exceedingly light. But unless your sketches are designed with these projection lines in mind you may make errors in projection from one view to another.

Before the sketch is finished, every dimension required by the workman must be placed on the drawing. Later in this lesson you shall learn how to do this, but for your ready reference we have shown a few examples below. Note how enough space must be left between views to allow for the insertion of dimensions. Note also that the dimensions do NOT refer to the size of the sketches at all, but indicate the sizes of the actual object. All we want is to have the lengths in proportion. Use a 4H pencil for all preliminary sketching. Heavy up the object outlines (but not the dimension lines) with an H pencil. Do not make any measurements when sketching. Proportion the lengths by the eye.

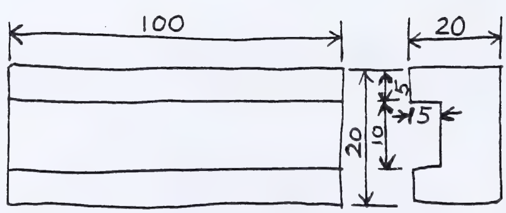




RECTANGULAR
BLOCK



HOLLOW BLOCK



CHANNEL BLOCK

LINES USED IN DRAFTING

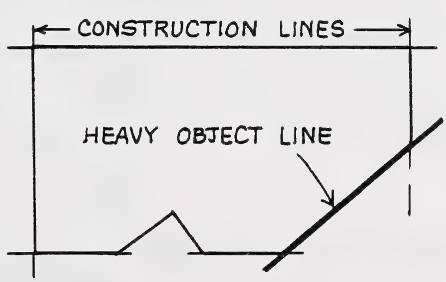
In lesson 14 you learned that for the majority of your work in this course two weights of line are used:

(a) light lines (which are drawn with a 4H pencil.)

(b) heavy lines (which are also drawn with a 4H pencil but afterwards they are darkened by going over them with the H pencil with a firm but not too heavy pressure.)

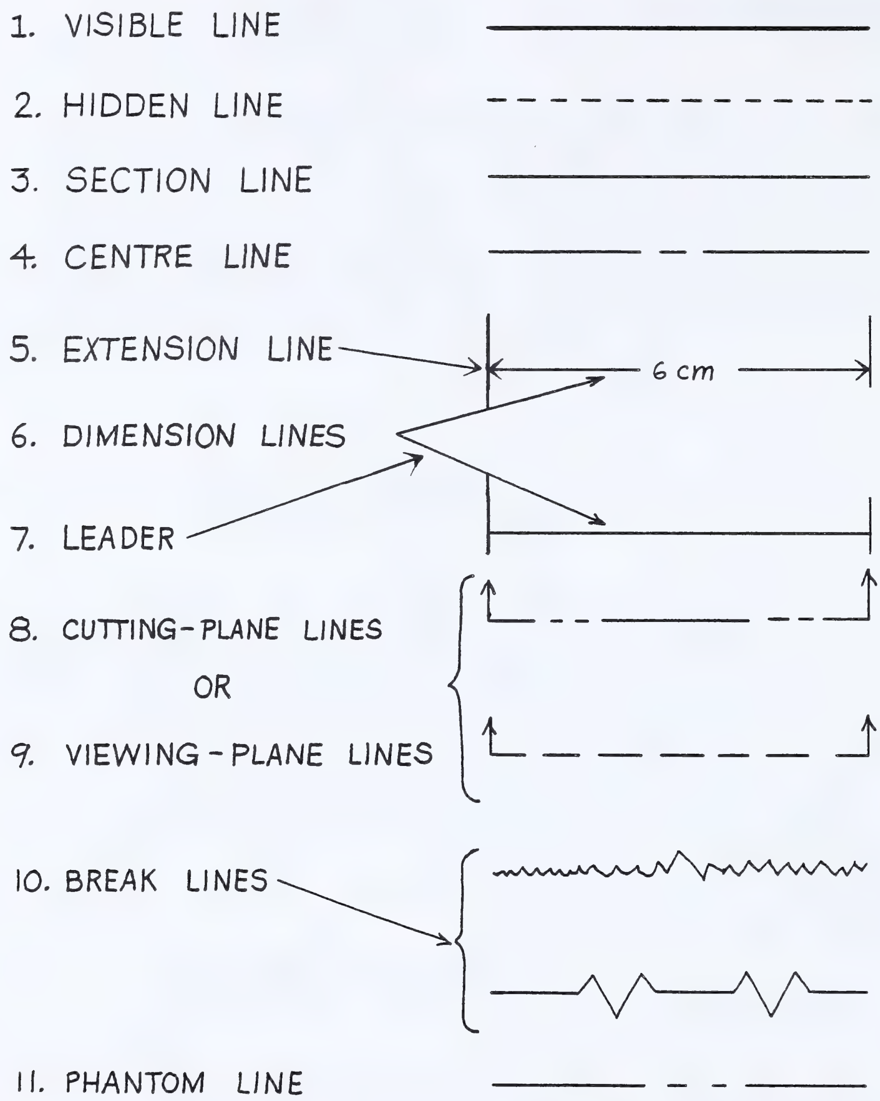
CAUTION: Heavy lines should never be thick lines. Any dense, black, thick line will smear the paper.

You should also be aware of another line which is commonly used and is a variation of the light line. The construction line is used to block in the exact shape of the object using extremely thin, light lines which should not interfere with the finished drawing. The 4H pencil is used to lightly draw in the construction line. Since construction lines are not intended to show on the finished drawing they are drawn so lightly they will just be visible to the draftsman (and they will not have to be erased). If a drawing is later gone over in ink these lines are not to be inked in. After inking they are erased. On pencil drawings they are not erased unless corrections are necessary. Guide lines, which are necessary to ensure uniform lettering (as in the title block), are of similar intensity.

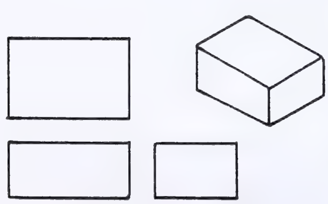


TYPES OF PENCIL LINES

Pencil lines should be clean, black and uniform with a distinct contrast between the light and heavy lines. The chart on page 10 shows the various types of lines used in making a drawing. The line contrast and individual line uniformity is extremely important for the clear and easy understanding of a drawing.

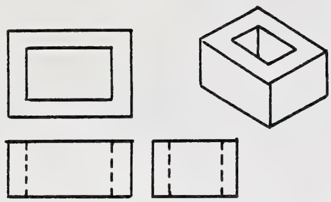


1. Visible Lines (or Border Lines or Object Edge Lines)



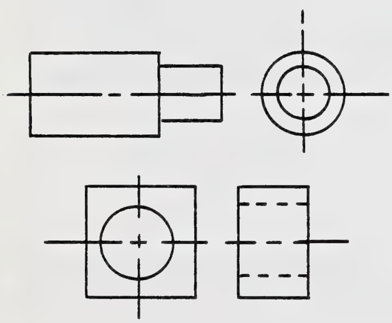
Visible lines are lines that are used to show the visible edges of objects as shown to the left. These are the most prominant lines on a drawing. Lay them out with a 4H pencil and darken with the H pencil.

2. Hidden Lines



Hidden lines are used to show the hidden edges of an object. The dashes should be about 3 mm long with approximately 1 mm spaces. These lengths may vary slightly with the size of the drawing. Use a 4H pencil and then darken them with the H pencil.

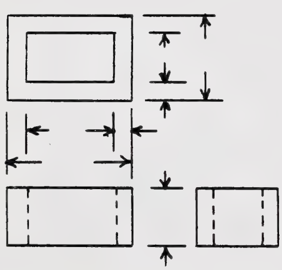
3. Centre Lines



Centre lines are used to indicate axes of circles, paths of motion, and symmetrical parts. The long dashes may vary from 20 mm to 40 mm in length.

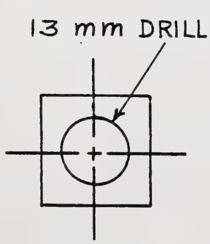
The short dashes should be approximately 1 mm long. Centre lines should start and end with long dashes and should not intersect at spaces between the dashes.

4. Extension and Dimension Lines



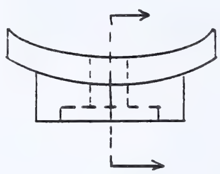
Extension lines extend from the visible lines and receive the dimension lines. Extension lines are short lines which tell to which part of the object the dimension refers. They should almost touch the line which they are extending and should extend 3 mm past the dimension line. Dimension lines are used to indicate the length and size of an object. They terminate with arrowheads. Both types of lines are lightly made with a 4H pencil.

5. Leaders



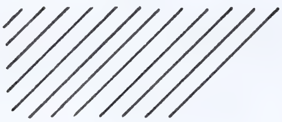
Leaders are used to direct notes or identification symbols to features on the drawing. Use a 4H pencil to layout and then darken with the H pencil.

6. Cutting Plane Lines



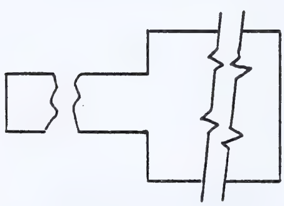
The cutting plane line is also referred to as the 'viewing plane line'. They are used to indicate direction and height of a partial view or removed section. The sectional view normally shows the area that cannot be seen in an orthographic view. The long dashes are 20 to 40 mm long and the two short dashes between each long one, are 3 mm long separated by 1 mm spaces. The lines are drawn with a 4H pencil and darkened with the H pencil.

7. Section Lines



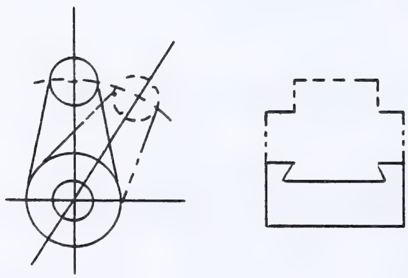
Section lines are used to show the cut surfaces in a sectional view. These lines are sometimes referred to as 'hatching lines'. They should be thin so as to contrast well with visible lines. Above all they should be equally spaced, proportionate to the size of the section, and at some other angle than the visible lines.

8. Break Lines



Break lines are used when it is desirable to shorten the view of a long part but only when this part has a uniform shape for the length that has been broken or omitted.

9. Phantom Lines

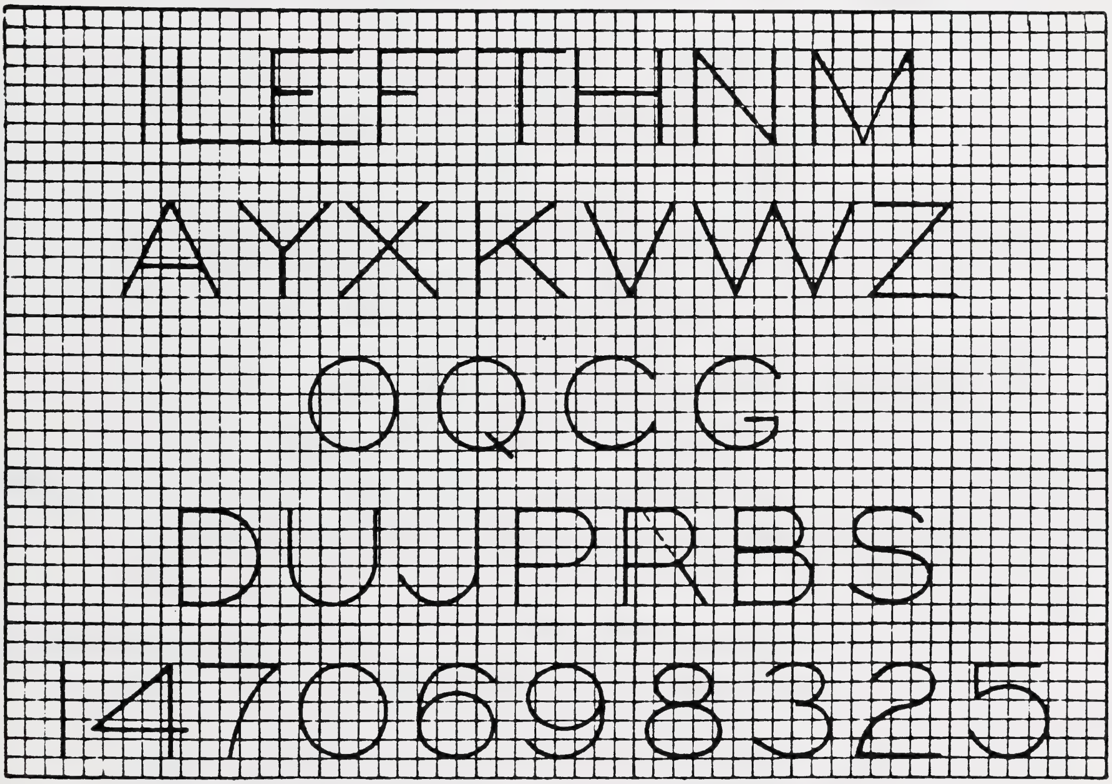


Phantom lines are used to show adjacent parts, alternate positions, and/or lines of motion. They are thin lines composed of long dashes varying from 20 mm to 40 mm and alternated with pairs of short dashes 3 mm in length with 1 mm spaces.

LETTERING

As well as dimension numbers, working drawings contain a considerable amount of words. These words include titles, scale indications, instructions on how to make holes and finish surfaces, etc. All lettering is done in the capital or upper case alphabet, A,B,C,D,E, etc. The lower case letters a,b,c,d,e, etc. are NEVER used.

A finished drawing is called a plate. Most of the lettering we shall use will be 3 mm high. But titles of the plates will be 5 mm high. However, to start out, we shall ask you to outline much larger letters to enable you to note the details of their form and proportions more closely.



(a) (i) The letters in the first row are made up mainly of horizontal and vertical strokes.

(ii) Most letters are four units wide, but the base of E is longer than the top; the top of T is 4½ units; H is a little wider than 4 units; M. is 5 units wide.

(b) (i) The letters in the second row consist mainly of diagonal strokes.

(ii) A is 5 units wide; X , K and Z are wider at the base than at the top; W is 8 units wide.

(c) The letters in the third row are made up mainly of curved strokes. These curves are ellipses, not circles, E.g. O is not a circle O but is higher than it is wide.

(d) (i) The letters in the fourth row are a combination of straight strokes and curves.

(ii) Note that R , B and S are wider in the lower portion than the upper.

(e) The numerals 8 , 3 , 2 , and 5 are wider in the lower portion than the upper.

The reason several of the characters are wider at the base is so that they will not look top heavy but give a feeling of stability.

1. Numerals

Lettering in drafting refers to drawing both letters and numerals. All lettering in drafting is done by first drawing very light guide lines. A pair of these lines is used to line up the top and bottom of all letters and numerals. The shape of each character should be uniform each time it is repeated and there is a set style for forming each which we should like you to adopt. There are formal rules for making the strokes but you can probably arrive at your own system which will enable you to reproduce the desired style for each character. We shall now point out the main features of each character as you should draw it. To begin with, we shall show each numeral placed between guide lines 4 mm apart. Note that guide lines are VERY light. Use a 4H pencil for this. Do your lettering with an H pencil. Beside each example, draw a succession of copies of the numeral to fill out the line.

SELF CORRECTING EXERCISE 1

Repeat each numeral between 5 and 10 times.

A single, dead upright stroke. 1 1

2 2

The upper portion is balanced over the base which is the widest portion.

3

Lower loop larger than upper. Do not use the 3 style as this resembles 5 too closely.

4 4

Draw the ∠ portion first, then add the | stroke. Keep the — stroke well below the middle height.

5 5

Draw the 5 first, then add the short bar at the top. Avoid 5 or 5 or 5 .

6 6

Note the 3 strokes, reverse direction with each stroke. Avoid 6 .

7 7

Avoid 7 .

8

Draw two ellipses, one under the other. Avoid 8 or 8 .

9 9 9

Avoid 9 .

0 0

Draw zero in two strokes. It is an ellipse, not a circle.

2. Letters

We shall note the features of each of the letters as we did the numerals. Again, complete each line with about ten copies of the letter. Note the individual steps in forming each letter.

SELF CORRECTING EXERCISE 2

A A

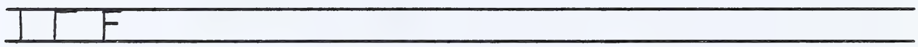
Base is as wide as height. Avoid A A

B

Avoid 

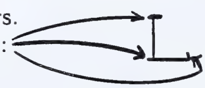
The two strokes in opposite directions avoid a tilted letter.

Avoid 

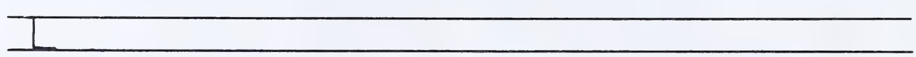


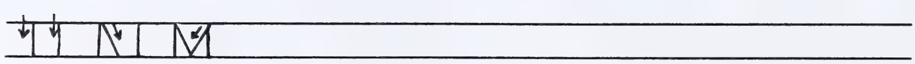
Avoid 

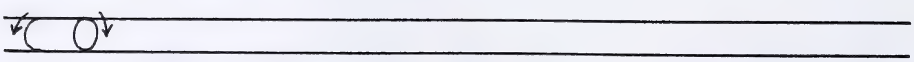
Avoid 

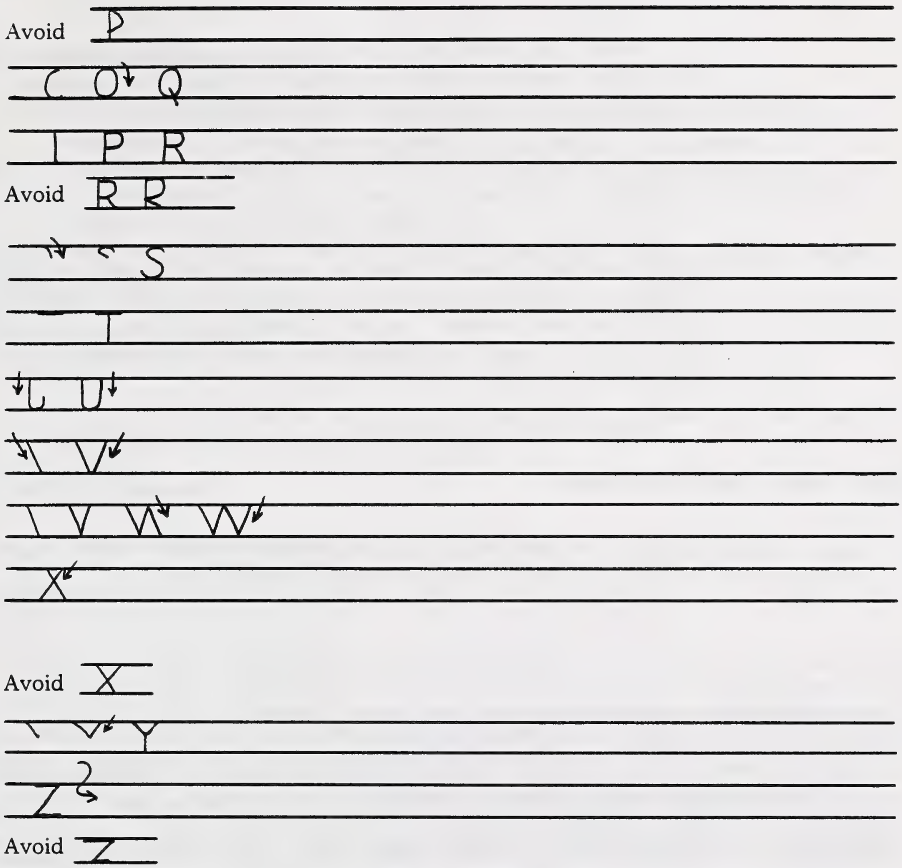
Avoid  . There are NO serifs on drafting letters.
The letter i and numeral one are the same. Serifs: 

Avoid 









3. Spacing Letters and Words

It is a contradictory fact that if the letters in a word are each spaced an equal distance apart, they will NOT appear that way to the eye. For example observe:

DISTANCE, GO, IN, LAY,

The distance from the extreme right end of each letter to the extreme left end of the next letter is equal in each case but the T and left A in 'distance' appear too far from the letters beside them; the spacing in 'go' seems wider than in 'in'; and the Y in 'lay' seems to be away off by itself. The fact is that for letters to appear evenly spaced it is the areas of the spaces between the letters that should appear equal, not the end-to-end distances. Thus letters with curved sides are placed closer to one another than the average spacing, as are letters with slanting sides. Compare the two lines below:

DISTANCE, GO, IN, LAY,

DISTANCE, GO, IN, LAY,

Rather than worry with hard and fast rules for spacing every pair of letters that may come together, you can use your own judgement in spacing to try to get the letters in each word so that they look uniformly spaced.

Spacing between words should be at least as wide as a standard letter such as H or N .

All lettering on drawings should be done between ruled guide lines even if only one short word is involved. Dimension numerals should all be the same height. You may be able to accomplish this without guide lines but if not, don't be reluctant to rule guide lines even though only one numeral may be required. See that all guide lines are very light and made with a very sharp pencil. Do not attempt to erase them from the finished drawing in pencil drawings.

To get a feel for good spacing copy the following example.

SELF CORRECTING EXERCISE 3

Practice spacing out the words and letters shown below in the nine pairs of 3 mm guide lines drawn at the bottom of this page.

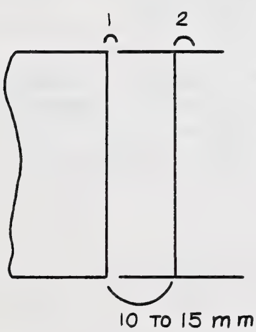
FINE FILE METAL FILAMENT WAX FILLET MANY A KINK
KEYWAY LIMIT LOCATION OF OIL HOLE CONNECTING LINK
CHUCK MOUNTING HIGH QUALITY ALUMINUM JOURNAL BOX
MOTOR GENERATOR DADO JOINT DOUBLE-HUNG WINDOW
POPPET VALVES PISTON RINGS 120 INCH WHEEL BASE
BRONZE BEARINGS AIRPLANES ZOOM IN THE SKY
FULL VACUUM SYSTEM EQUIPPED WITH AMPLIFIERS
PUBLIC SCHOOLS INDUSTRIAL ARTS DEPARTMENT
SCALE: FULL SIZE DRAWING A-425 9-10-1938

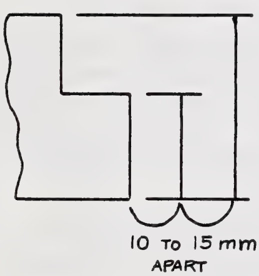
STEPS IN MAKING A WORKING DRAWING

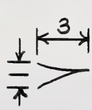
(a) The paper is fastened to the drawing board with the long side horizontal. The method used to ensure that the paper lies flat was stated in lesson 14.
(b) The necessary measurements are made to locate the lines which will be drawn.
(c) The outlines of the object in each view are drawn using the measurements and construction lines explained earlier.
(d) Space is provided between the views to allow for the insertion of all necessary dimensions.
(e) The dimensions are inserted. All the drawing has so far been done with a 4H pencil.
(f) The object lines (only) are heavied up with an H pencil.

When you come to making up finished plates of working drawings, the paper will be first ruled with proper border and title strips.

DIMENSIONING A WORKING DRAWING







ENLARGED ARROWHEAD

DIRECTION OF PENCIL STROKES

We shall now discuss dimensioning so that you will know how to space out the lines of working drawings so that the dimensions can be inserted in their correct places.

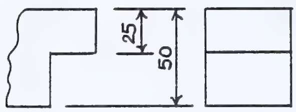
(a) After blocking in the views, make the extension lines distinct with the 4H pencil. Many of them will lie on top of construction or projection lines so they can be shown by heavying up a portion of the projection line slightly with the 4H pencil. Start each extention line 1 mm from the object edge line and make it long enough to extend 2 mm beyond the dimension lines when drawn.
(b) Place dimensions 10 mm or more from the object. (Never crowd the dimensions against the side of the object.) If there is more than one dimension place them evenly apart as shown on page 21. Uniform placing of dimension lines not only makes the drawing look better, but it makes it more convenient to read.
(c) With a 4H pencil draw each dimension line so it starts and stops EXACTLY at the extension line. Leave no opening since the dimension figure is now placed above the line.
(d) Make neat arrowheads at each end of a dimension line, placing them so the points are exactly at the extention lines. Follow these instructions when making arrowheads.

(i) Make arrowheads with a 4H pencil.
(ii) The arrowhead should be very slender and the sides should be graceful curves. The approximate sizes are shown in the drawing to the left but these may vary to suit the space and in accordance with your own individual styling. But do not space between their sides. Any solid pencil shading tends to smudge.
(iii) The two curves are made with a single stroke: from outer end to point and back to the other outer end.

(e) Make the figures for the whole numbers 3 mm high. Fractions are not used with SI metric.

(f) The dimension figures refer to the size of the finished object, NOT to the drawing lengths. If all dimensions are in the same units do not include the unit with the dimension figure. In this course all dimensions are for the most part in millimetres so just use the numbers and OMIT the 'mm.'

(g) The figures for horizontal dimensions should read from the bottom of the drawing. E.g. 50 The figures for vertical dimensions should read from the right side: E.g. 30



(h) Keep dimensions OUTSIDE the object whenever possible. Sometimes this cannot be done without long extension lines, in which case they must go within the object as in the grooved block drawing on page 21.

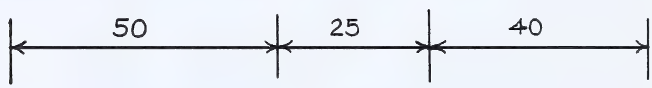
(i) Place dimensions BETWEEN views whenever two views can be dimensioned with one line, but apply each dimension to one view.

(j) Give a dimension of a single part ONLY ONCE even though that part appears in several views.

(k) When there are several short and long dimensions together place the short ones next to the view and the longer ones farther out so that extension lines do not cross dimension lines.

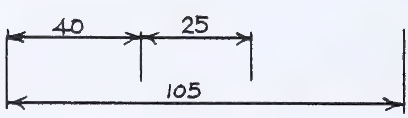
(l) When a space is too small to place dimension lines between the extension lines, place short dimension lines outside of the extension lines. The figure can be placed inside the extension lines if there is enough space or it can be outside of the extension lines if the space between is too small for a figure.

(m) When there are several dimensions in a row, the dimension lines should form a single line.

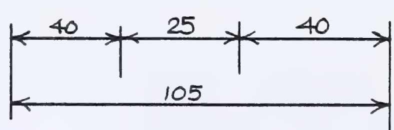


NOTE: There will often be several object and extension lines in line with one another. Try to anticipate this and draw all of them with a single setting of the T-square, or triangle and T-square in the case of vertical lines. There is no harm in drawing a single long construction line very lightly and then going over the portions of this which are required for object edge lines and extension lines.

(n) When a length is broken down into parts do not duplicate a dimension by dimensioning all the parts AND the total length.

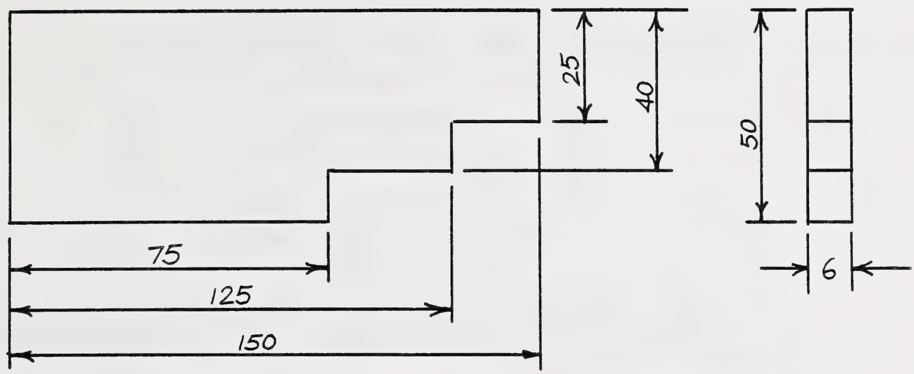


RIGHT

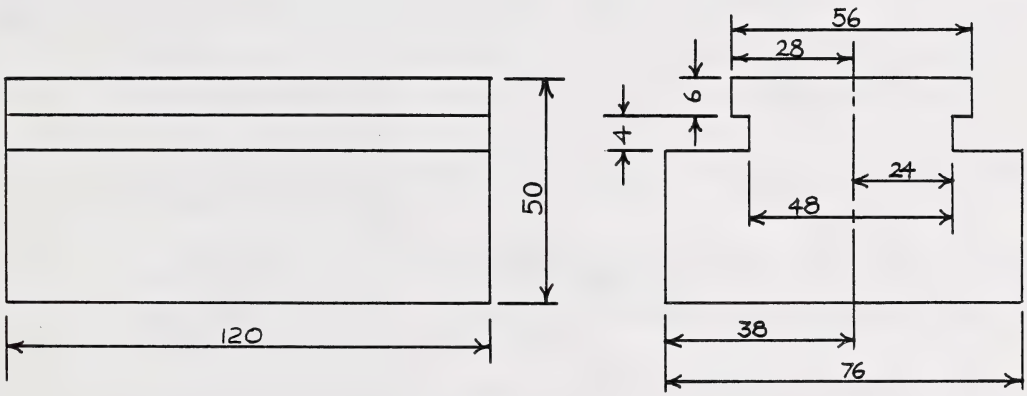


WRONG

NOTE: Always give the total length instead of one of the similar dimensions.



Dimensioned drawing of a windowstick



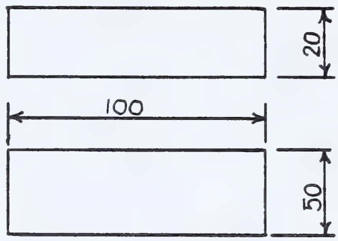
Grooved block (Note dimensioning from centre line in the right side view)

CENTERING (OR BLOCKING IN) A PLATE

Whatever drawing is to be made, it will be first necessary to center it on the plate before any of the details can be drawn in.

Nothing can be done on the drawing board until a sketch has first been made freehand on a separate piece of paper. This will show you all the items which must appear on the drawing in their proper relative positions. With this information you will be able to see where the center of the drawing is, and then lay out your measurements accordingly.

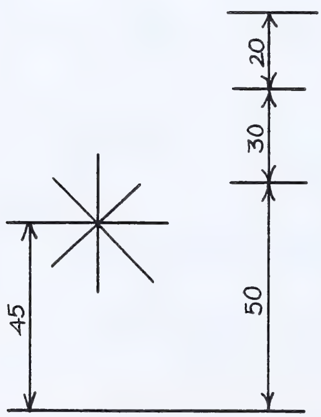
Take the following example. The drawing is for a rectangular block so two views are adequate. Suppose we decide to draw the front and top views. Our sketch is like this:



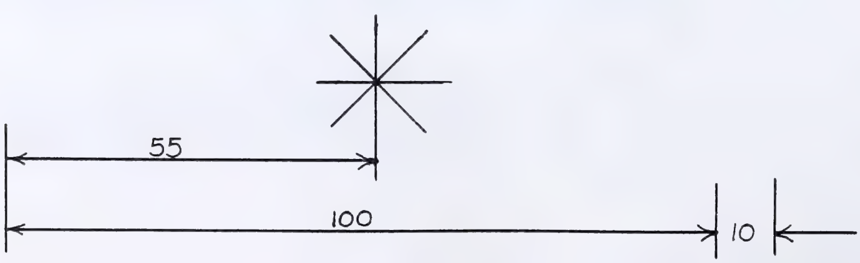
We will leave 30 mm between views for dimensioning and so the over-all height of the drawing is 100 mm. The dimensions on the right project about 10 mm so the over-all length is 110 mm.

Now you have as your starting point the center of the plate which was what you found as the first procedure in laying out your plate.

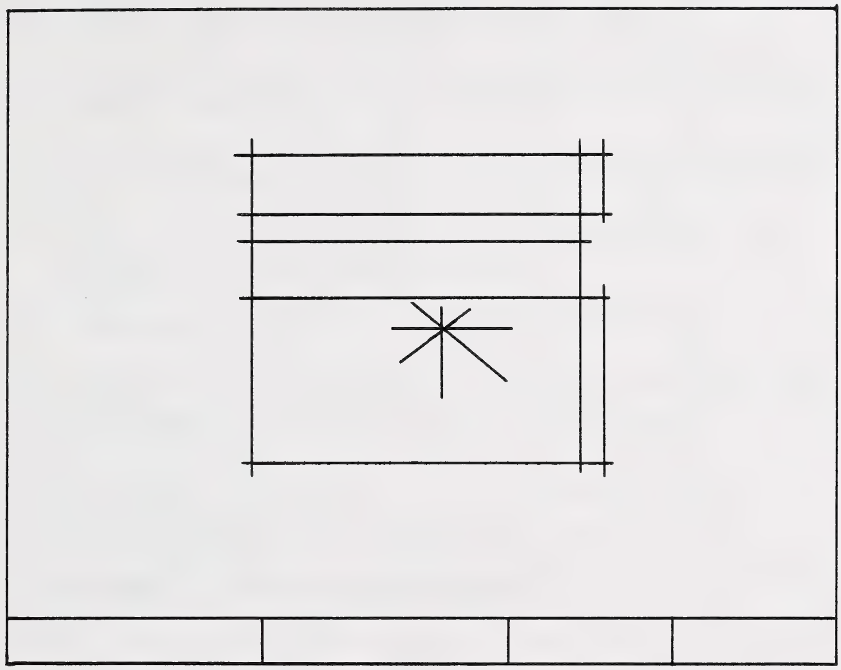
Since our drawing is to be 100 mm high, measure down half this distance from the center, namely 50 mm. However the center of the plate is not the center of the drawing because 11 mm was taken up by the record strip. So to center the drawing deduct 5 mm. The bottom of the drawing will be 45 mm below the center. Starting then, 45 mm down from the center, mark the horizontal lines you will require:



The over-all length of the drawing is 110 mm (allowing 10 mm for dimensioning), so the left edge of the drawing will be 55 mm from the center. Note the line locations shown below.



You now have the positions of your 5 horizontal lines and 3 vertical lines. With a T-square rule all the horizontal lines from the top one down. Then place a triangle on the T-square and draw all the vertical lines, in order, starting at the left side. When the blocking in has been done you will have these lines, all very lightly drawn with your 4H pencil.



Your drawing has now been blocked in so that it is centered on the plate and fills the space available adequately.

The extension lines, dimension lines, and arrowheads can now be outlined on top of these guide lines. When the dimension numerals have been inserted, the object edge lines, borders, and record strip partitions heavied up with H pencil, and the record strip lettered, the drawing will be complete.

It is not necessary to draw continuous lines when blocking in. You can see from your sketch where gaps should occur and you can make the extension lines the correct length to begin with, instead of drawing them on top of a continuous line. But the important thing is to line up all segments which are in line and draw them with a single setting of the T-square, or triangle.

1. Front and Side Views

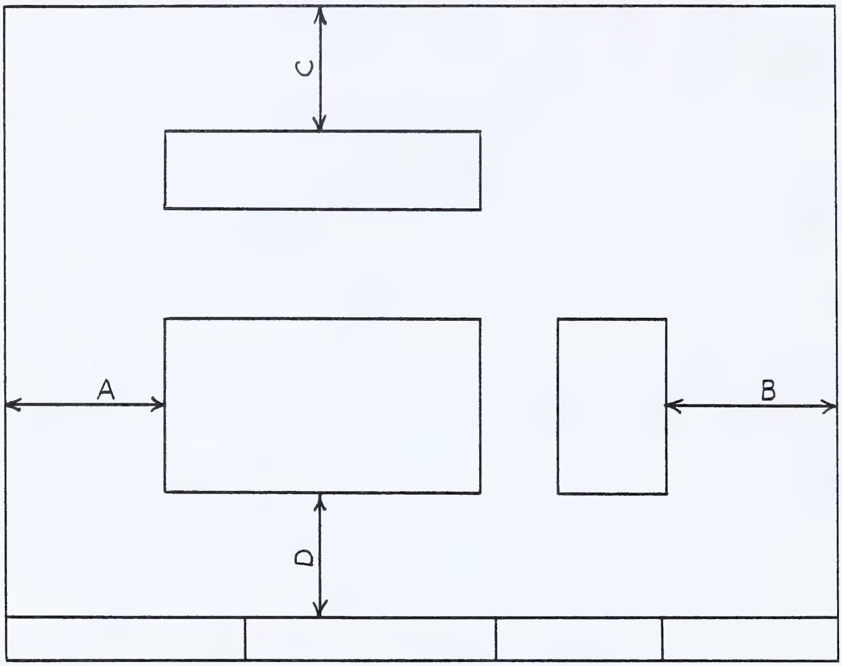
If your drawing consists of front and side views, add together all the lengths you will require including enough space for dimensions, as determined from your sketch, divide by two, and then measure off this distance to the left of your center line, to find the left end of the drawing.

Similarily, find the total height you will require and measure down half of this distance from the center, but subtract 5 mm to allow for the off-centering effect of the record strip.

2. Three Views

The same system is used for a 3-view drawing. The left end of the front view will be as far from the left border as the right end of the right-side view (including dimension lines) is from the right border.

Similarly, this is true for the top and bottom of a drawing, as illustrated below.



A = B C = D

KEEPING THE DRAWING CLEAN

One of the true marks of a good draftsman is his ability to produce clean drawings. Every student of drafting should strive to make cleanliness a personal habit. To help the student achieve this end the list below represents commonly adhered to practices that should be adopted.

(a) Always wipe off or wash equipment with soap and lukewarm water before using them. Metal instruments should only be dry wiped and hot water should never be used (the former will prevent rusting while the latter will prevent warping).

(b) Be sure that the hands are clean. If the hands tend to perspire, wash them frequently.

(c) Clothing must be clean, sweaters or coats should be removed, and long sleeves should be rolled up.

(d) Equipment such as the set squares and T-square in particular should be washed frequently and dried immediately thereafter.

(e) Keep the hands and objects off and away from penciled areas whenever possible.

(f) Avoid sliding drafting instruments and equipment over penciled areas.

(g) Eraser particles should never be removed with the hand, fingers, or palm. Use a draftsman's brush or a soft cloth to remove these particles.

(h) A completed drawing should never be worked over, i.e., heavy-in the construction lines once only.

(i) Never sharpen the pencil over a drawing. After sharpening the pencil point, wipe it with a clean cloth or soft tissue paper to remove particles of graphite.

(j) Never place the sandpaper block in a drawer along with other drafting instruments unless it is completely enclosed.

(k) Always cover the drawing at the end of the drawing period.

(l) Avoid handling the drawing in any way that will cause smudges, folds, or creases.

Complete the following exercises and submit them for correction.

EXERCISE 1

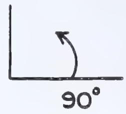
1. In the space below, with an H pencil, draw six examples of

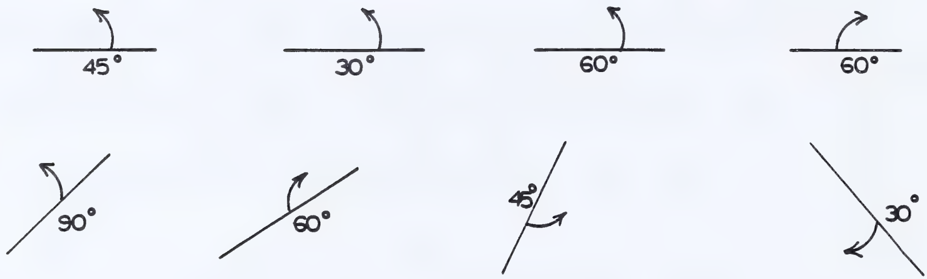
(a) horizontal lines (b) vertical lines

(c) squares (d)  shapes

2. In the space below complete a sketch of each angle ABOVE the arm already drawn as indicated by the arrow. Estimate the size of the angle. Do not use any instruments to measure with.

Example:



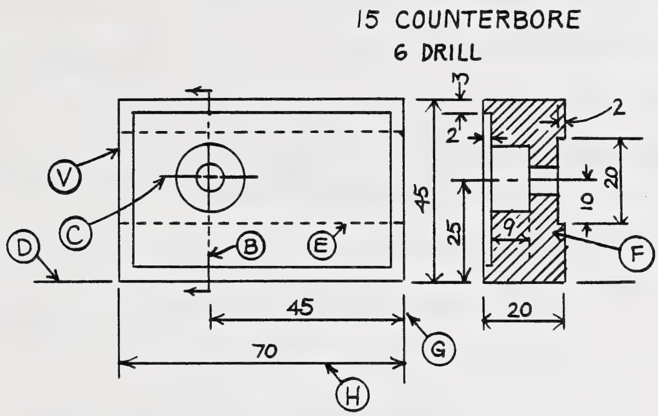


3. Below each heading sketch at least three angles of approximately the size called for in the heading. Make some of the angles so that neither side is horizontal nor vertical. Do not use any measuring instruments.

30° 45° 60° 90°

EXERCISE 2

1. Match the names of the lines shown on page 10 of this lesson with the lines with letters on the jig shown below.



V - *Object edge line*

F - *Cross hatching*

C - ______

D - ______

E - ______

B - ______

G - ______

H - ______

Working drawing of a jig.

2. The line shows where a measurement stops is a:

(a) section line, (b) parallel line, (c) extension line,

(d) visible outline, (e) heavy line (Underline the correct word or words.)

EXERCISE 3

Write the word 'true' in the space to the left of each true statement. For each false statement write in the word 'false'.

______ 1. In a working drawing, the top view is placed exactly above the front view.

______ 2. The right side view is placed in line with and to the right of the top view in an orthographic projection.

______ 3. A working drawing must include dimensions.

______ 4. Every working drawing must show all dimensions on all the views even though the edges are repeated.

______ 5. In making dimension and extension lines, you would use an H pencil.

______ 6. Place dimensions between views whenever possible.

EXERCISE 4

Fill in the blanks with the appropriate letter, word, or number.

1. Whole numbers are ______________________________ mm high.
2. Extension lines should continue ______________ mm beyond the arrowheads.
3. A photograph does not show the necessary ___________ for making an object.
4. Some letters are made wider at the bottom to give an appearance of ________ .
5. The letter which is similar to E is ___________, to X is ___________, to V is ___________, to C is ___________, and to U is ___________.
6. What letter is similar to Q? ______________________________
7. What letter is similar to R? ______________________________

EXERCISE 5

1. What two grades of pencil are recommended for students in this course?

   ____

2. What are hidden lines?

   ____

   ____

3. What is the difference between a sketch and a drawing?

   ____

   ____

4. What is the difference between a pictorial drawing and an orthographic drawing?

   ____

   ____

5. What is the difference between a working drawing and a finished plate?

   ____

   ____

6. Why does a simple rectangular block require a working drawing with only two views?

   ____

   ____

7. Describe the procedure for sharpening a drafting pencil.

8. Why is it unprofessional to do drafting with dirty hands? (We all know that this is because it will make the drawing dirty, but why is it unprofessional?) Explain fully, use your own ideas but do not leave this question blank.

EXERCISE 6

Draw the letters shown on the graph paper on page 13 of this lesson on the squared chart below. Be sure to draw all lines freehand as instruments are never used in lettering except to draw guide lines. Note carefully the spacing of the width and height of each letter. See that the separation between the letters is the same as shown on page 13. Use an H pencil for lettering.

EXERCISE 7

In the space below make a sketch of a working drawing for each of the three objects on page 8; the rectangular block, the hollow block, and the channel block. Leave in the construction lines required to project the views shown.

EXERCISE 8

You are now going to use your drawing board, T-square, triangles, and scale to make two drawings. Use the proper methods as discussed in lesson 14 plus this lesson.

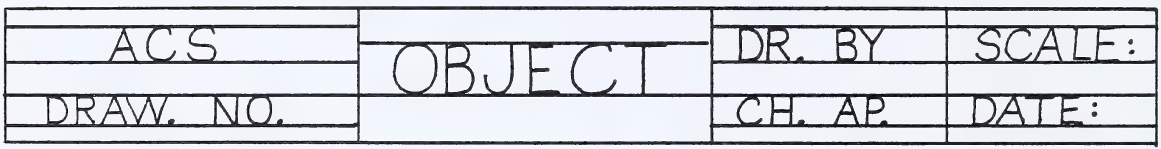
Copy the two drawings shown on page 21 of this lesson, full size, each on one sheet of drawing paper with prepared borders. Give all dimensions. Use your hard or 4H pencil for laying out the drawing. Remember to carry out all the instructions you have learned.

1. Fasten the paper to the board with the long side horizontal, carrying out each step as instructed in lesson 14. Remember that there is a best way to do this. Resolve to use that way at the outset so as to make your work easier and your success greater.

2. Before you can locate any of the lines you are to draw, you will have to center the drawings on the pages. Follow the methods outlined earlier in this lesson.

3. Now draw the lines as instructed under 'Drawing Horizontal and Vertical Lines' in Lesson 14. Object edges are to be gone over with the soft H pencil after the drawing is laid out.

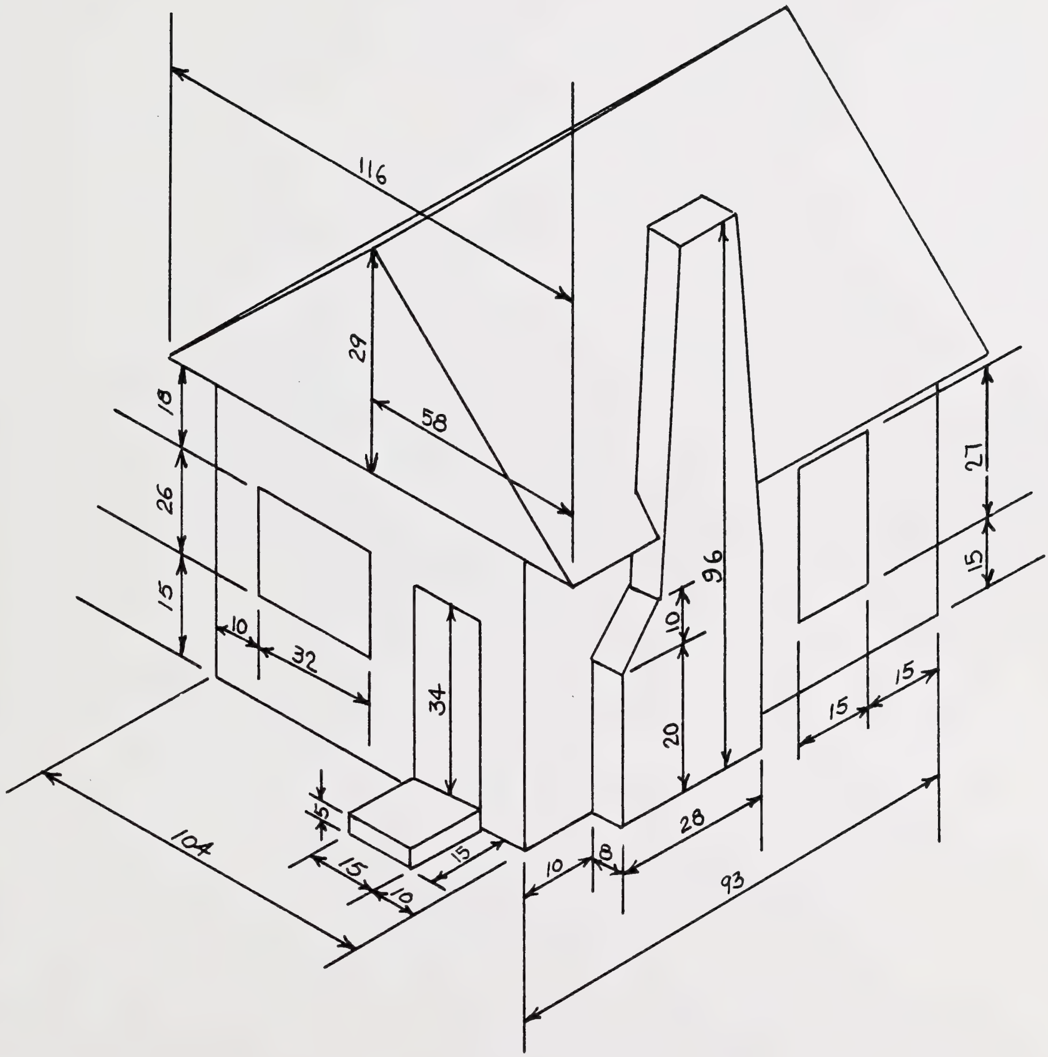
4. The record strip is to be lettered as follows.



After DR. BY (drawn by), sign your name. After CH. (checked) write your initials after you have checked to see that all details of your drawing are correct. AP. stands for 'approved'. If your drawing is found to be correct your correspondence teacher may initial it in this space after A.P. In the OBJECT space you are to letter the name of the object being drawn. After DATE: indicate the date the object was drawn (using metric terminology). After SCALE: indicate the scale used. After DRAW NO. indicate whether the plate is drawing number 1, 2, 3, etc.

EXERCISE 9

A student is designing a house he will build for his model railway system. The basic design is shown below. On one sheet of drawing paper with prepared borders draw the front view (the view with the doorway) of the house. Use your drawing board, T-square, triangles, and scale. Proper methods of drawing as discussed so far in this course must be used. List all front view dimensions. Use a 1:1 scale. Steps 1 through 4 as listed in Exercise 8 should also be followed.



END OF LESSON 15

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY	
Date Lesson Submitted ______	(If label is missing or incorrect)
Time Spent on Lesson ______	File Number ______
	Lesson Number ______

FOR SCHOOL USE ONLY

Assigned Teacher: ______

Lesson Grading: ______

Additional Grading E/R/P Code: ______

Mark: ______

Graded by: ______

Assignment Code: ______

Date Lesson Received: ______

Lesson Recorded ______

Student's Questions and Comments

Apply Lesson Label Here

Name ______

Address ______

Postal Code ______

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

______
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

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PRACTICAL PROJECT

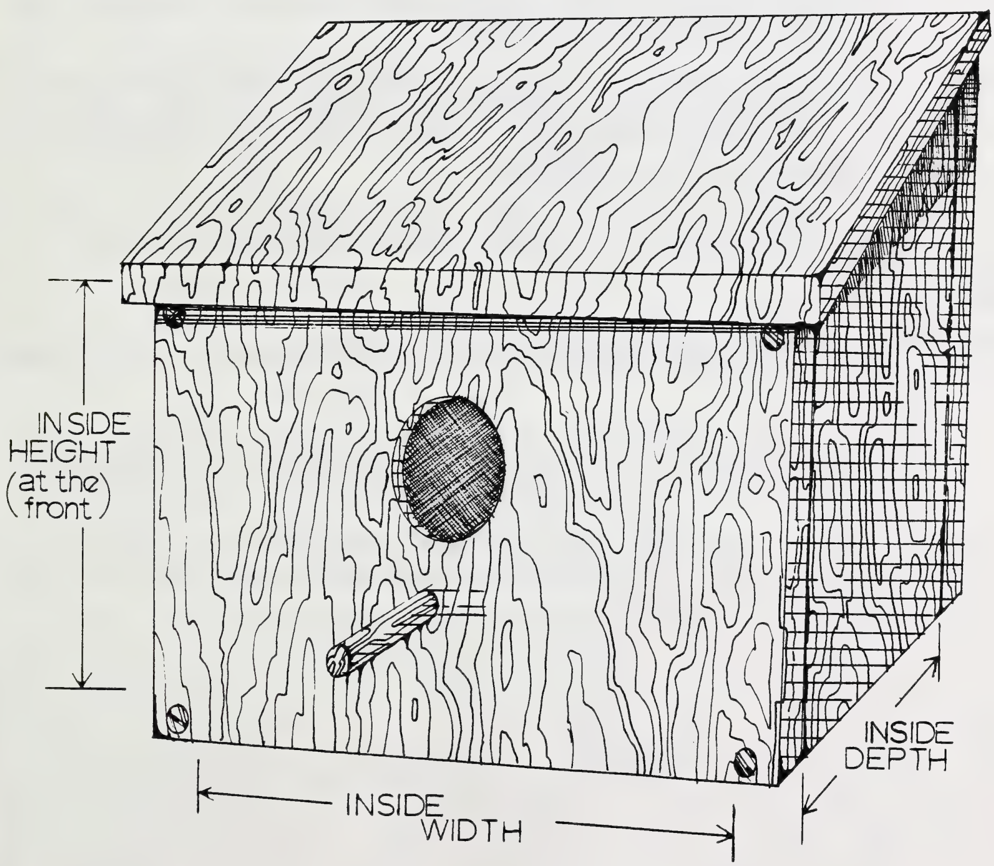
Materials
Construction details
Sizes
Location
Project Assignment

INTRODUCTION

This is the project lesson. The project lesson must be done OR you will receive no credits in this course.

Actually we think you will find this to be an interesting project because not only will you get some practice but you will learn a bit about birds too, since the project is building a bird house.

A bird house is much more than just a box with a hole in it. It must be weatherproof, waterproof, the right size for the particular bird you want to live in it, the right color, relatively easy to build, properly ventilated, etc.



A DRAWING OF A GOOD BIRDHOUSE.

(you will have to draw GOOD final plans in this lesson).

MATERIALS

1. Use well seasoned woods such as redwood, western cedar, pine, or spruce. 19 mm thickness will be the easiest to obtain and to work with.

2. To prevent rusting and eventual loosening of the bird house use only galvanized, aluminum, or brass hardware including nails and screws.

3. Since this house must be waterproof you must use a waterproof glue. What kind would this be? You should know by now but if you don't, then better check Lesson 10 for the right kind of glue.

4. Also you will need to paint or stain your birdhouse. A lot of people make the mistake of painting their birdhouse bright vivid colors like bright red and white. This just scares off most birds. A better color would be a dull brown or dull green or a grey. It should not be too dark or the box will get too hot in the sun.

   We suggest using alkyd resin paints. (Why? If you don't know you need to review Lesson 8.) Here is a suggestion for a color scheme that should make the birds feel right at home. Mix a little dull brown paint with some dull green and dull grey, but stir it only slightly. DO NOT MIX the colors. Do this in a small jar like an empty baby food jar (make sure there's no baby food in there.) Then paint the house with this and it should give you a nice mottled effect (like army camouflage) that comes close to duplicating the bird's natural environment. Give it two coats at least for good waterproofing.

   Or if you wish you can stain your birdhouse with a nice wood stain. Use a medium or light color since a dark stain will make the house too hot in the sun. Be sure to varnish the house after you stain it. (Why? If you don't know see Lesson 8.)

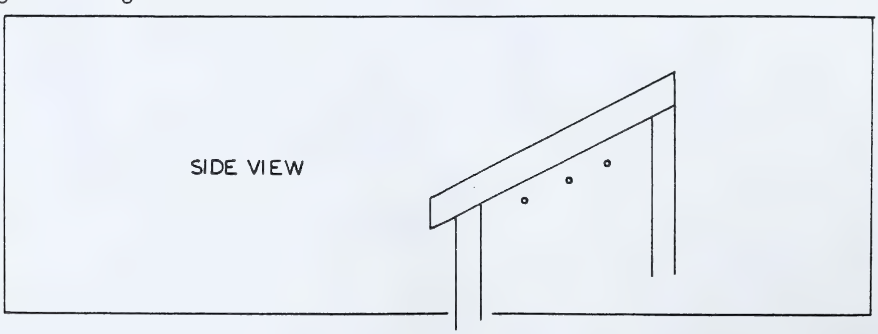
   Also give the inside of the house a light coat of paint (especially the floor) as this will make it easier to clean. Use a small paint brush to do the inside.

CONSTRUCTION DETAILS

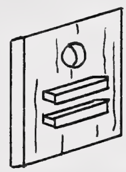
Follow carefully the directions given in this section as you construct your birdhouse project.

1. Build your box especially for a certain species of bird. Don't just make it any old size. It must have the right size hole, height above the floor, etc. Use the chart at the end of this lesson to determine the dimensions for the type of bird you want.

2. Drill 2 or 3 small 6 mm holes in each side just under the edges of the roof for ventilation. Make sure the holes are at a slight upward angle so that water won't get in through them.

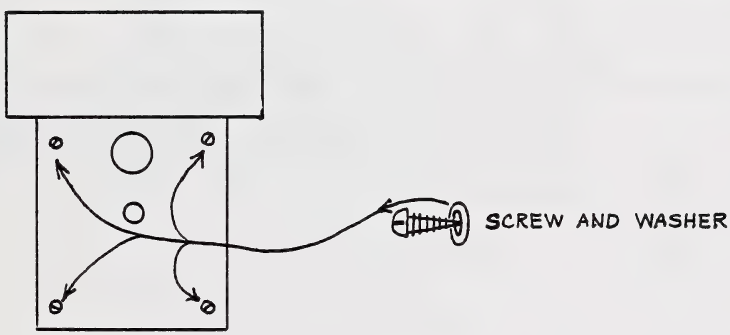


3. Provide steps on the inside of the house so the birds can get out. Glue one or two small cleats below the entrance hole on the inside.

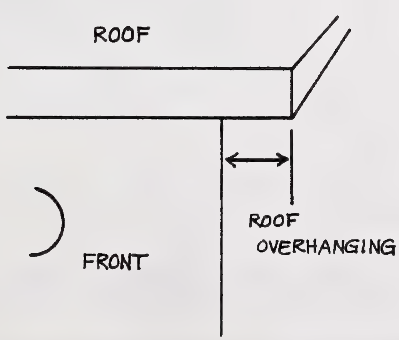


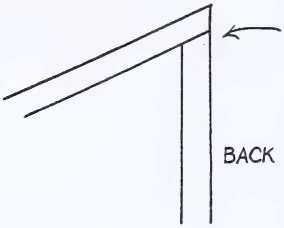
4. The birdhouse needs a door. This is so the box can be opened for cleaning after the nesting season. This cleaning is to help prevent the formation of parasites inside the house. The door can be kept closed by the use of four round head screws, each with a flat washer under its head.

   Make sure the door fits tightly. This is important for although birds can take cold, they do not like drafts. One can make sure there are no drafts by having the door fit very tightly. This means not only accurate sawing but also using a straight unwarped piece of wood. Make sure you check your wood for straightness before using it.



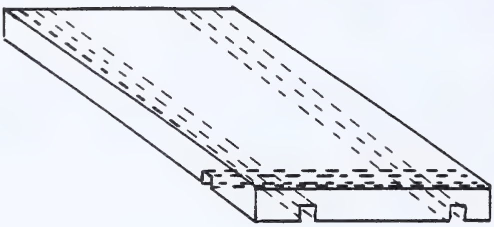
5. You want a birdhouse which is waterproof. Make the roof so it extends 50 mm over the sides and front. On larger birdhouses, the overhang to the front could be increased.





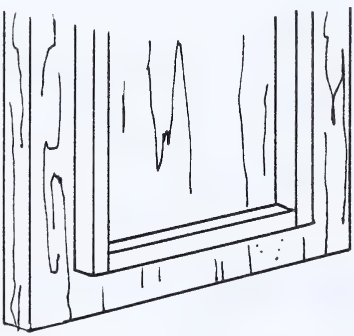
There is no need for an extension at the back of the box since this is the side which will be mounted on a tree or post and the overhang would get in the way. Just make sure the joint is very tight at this point. Make an accurate fitting joint and glue it well.

6. The roof will need a drip line cut into three sides of the lower part of the roof panel. This prevents the water from flowing around the underside of the roof and collecting in the joints or flowing through the ventilation holes. (You may have noticed drip lines are cut on the lower outer edges of window frames for the same reason.)

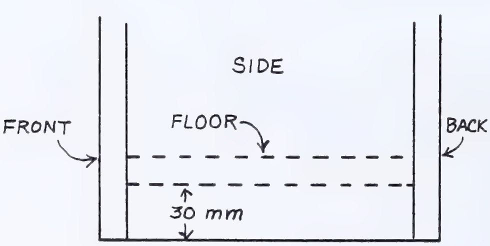


The drip line can be cut by carefully following your layout lines with a back saw. A narrow wood chisel could also be used but the job would take longer and be more difficult.

7. You will also need to waterproof the door so water will not get in through the cracks. The way to do this on your birdhouse is to glue small wood strips about 15 mm square on the inside of the door. These must be positioned so that they make a tight fit when the door is closed or they will be useless.

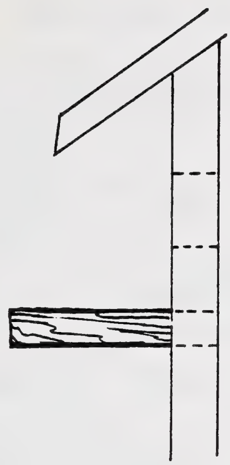


8. Have the front, sides and back project beyond the floor by 30 mm to ensure extra waterproofing. Also drill two 6 mm holes near the centre of the floor to allow for drainage should any water enter through the birds entrance hole.



9. Birds need something to land on so provide a dowel as a perch. Make sure it is glued in securely so that it stays put and so no water will leak in.

Use a small diameter dowel for small birds and a larger one for large birds (such as a barn owl).



As you can see, a bird house really is much more than a simple box. It requires much careful layout, sawing, planing, and sanding if it is to turn out as a good looking project. Remember, to look good, there should be no saw marks on any of the edges.

SIZES

CHART OF DIMENSIONS FOR VARIOUS BIRDS

These are INSIDE dimensions. So when you cut your lumber you will have to make the outside dimensions bigger to compensate for the thickness of the lumber.

Bird	Inside Width of Floor	Inside Depth of Floor	Exact Size of Entrance	Height of Entrance Above Floor	Inside Height of Box
House Wren	100 mm	100 mm	22 mm × 64 mm wide	125 mm	150 - 200 mm
Berwick's Wren (South)	100 mm	100 mm	25 mm × 64 mm	100 - 150 mm	150 - 200 mm
Bluebird	115 mm	115 mm	38 mm diameter	150 mm	215 mm
Tree Swallow	170 mm	270 mm	38 mm diameter	120 mm	215 mm
Barn Owl	500 mm	500 mm	160 m diameter	250 mm	460 mm
Wood Duck	230 mm	250 mm	102 mm diameter	355 mm	560 mm
Downy Woodpecker	100 mm	100 mm	32 mm diameter	150 - 200 mm	500 - 250 mm
Hairy Woodpecker	150 mm	150 mm	38 mm diameter	230 - 300 mm	300 - 380 mm
Crested Flycatcher	150 mm	150 mm	51 mm diameter	150 - 200 mm	200 - 250 mm
Nuthatches	100 mm	100 mm	32 mm diameter	150 - 200 mm	200 - 250 mm
Chickadees	100 mm	100 mm	32 mm diameter	175 mm	225 mm
Titmice	100 mm	100 mm	32 mm diameter	175 mm	225 mm
Saw-Whet Owl	230 mm	230 mm	83 mm diameter	275 mm	350 mm

The last 7 species in this chart definitely prefer a birdhouse that is covered on the outside with bark, to give a natural, 'log-house look'.

LOCATION

What do you do with your birdhouse after it is returned from your teacher after marking?

You can erect it in the location and at the height given in the chart below.

Bird	Height Above Ground	Where to put it
Wrens Bluebirds Tree Swallows	2 - 3 m 2 - 3 m 2 - 4 m	Open areas in partial or full sunlight such as the edge of an open field, orchard or garden. Generally an open field post is preferred, they don't seem to like to be put up in the shady foliage of a tree.
Woodpeckers	3 - 6 m	Dead stub of a tree in groves, semi-open woodlands or on a telephone pole.
Flycatchers Nuthatches, Titmice Chickadee	2.5 m to 5 m	Prefer Woodland borders, but will sometimes nest in a garden area that is not too sunny.
Barn Owl	Variable	High silos, barn rafters, water towers - undisturbed areas
Saw-Whet Owl	3 - 10 m	Old orchards, open groves of trees. High up, on the main trunk.
Wood Duck	about 1.75 m	On a post in or near a marsh, pond, water.

As a general rule your birdhouse should be up by early spring if you want spring occupancy. The first of March would be a good date.

If your want more information on attracting birds, an absolutely first-rate book is: 'The New Handbook of Attracting Birds' by Thomas P. McElroy, Jr. published by McLelland & Steward Ltd.

PROJECT ASSIGNMENT

The project assignment involves several tasks. In order to make sure you complete each one, carefully follow the instructions given below.

1. Decide on the type of bird you want to build a birdhouse for. This will depend on your locality as well as your choice of which local bird to build the house for.

2. Draft a set of plans showing the front view and the right side view. Each view should be drawn on a separate sheet of paper. This is to be a properly drawn formal set of plans, not a sketch. Make sure to show the hidden lines on each view. The size of birdhouse can be taken from the chart of dimensions for various birds given on page 6 of this lesson.

3. Using the sizes taken from your plan, very carefully lay out the material. Once cut, the pieces can be planed down to the layout line. If the material was cut properly to begin with, there should be no saw marks left and the edges should be straight and square. Carefully follow construction details listed on pages 2, 3, 4 and 5.

4. Assemble the birdhouse. A review of Lesson 6, Assembly and Holding Tools, will yield information on the best mechanical fasteners and Lesson 10, Adhesives and Coated Abrasives, will give you information on the best glue to use.

5. Answer the questions on page 9.

6. Send the following items in to the Alberta Correspondence School for evaluation.

   (a) Your birdhouse - carefully pack it following the directions below.
   (b) the exercise on page 9.
   (c) your drafting plans.

7. Your mark will be based on the following items

   (a) Exactness of your drawing
   (b) How well you followed your plan.
   (c) Appearance and accuracy of your work.
   (d) Construction details such as choice of wood, fasteners, glue, and paint.

8. This project is worth 25% of your final mark so take your time and do a good job. If you have to build your birdhouse twice before getting a good one do not be discouraged as it takes much time and practice to do good work. This project is after all supposed to be a learning experience.

9. Pack your birdhouse in a good strong corrugated cardboard box. Fill the spaces between the birdhouse and the box with crumpled newspaper. Make sure the birdhouse is good and tight in the box and cannot shift around. We would suggest that you have at least 5 cm of tight packing around the birdhouse.

   Include the completed green 'Lesson Record Form'. Put this INSIDE the box.

   Tape the box securely and preferably also tie it with stout string.

   Fill out the address form enclosed and glue or tape it to the top of your box.

EXERCISE

Enclose the following pages with your bird house and send them to the Alberta Correspondence School.

1. What type of bird did you build the birdhouse for?

____

2. Make a list of the pieces of wood required for the birdhouse and their sizes.

	Number of pieces	part	thickness	×	width	×	length
(a)	________	top	________	×	________	×	________
(b)	________	sides	________	×	________	×	________
(c)	________	door	________	×	________	×	________
(d)	________	back	________	×	________	×	________
(e)	________	bottom	________	×	________	×	________
(f)	________	long weather____ × strip pieces	________	×	________	×	________
(g)	________	short weatherstrip pieces	________	×	________	×	________
(h)	________	peg	____diameter	×	________		length

3. What type of wood did you choose for your birdhouse?

____

4. Why did you choose this type of wood?

____

____

____

5. What type of nails did you use? (i.e. shingle, box, common, etc.)

____

6. Were they coated nails?________________________________

If yes, then what were they coated with?______________________

7. What type of paint did you use?

____

8. Why did you use this type of paint?

____

____

9. What type of glue did you use? ______________________________

What brand was it? ______________________________

10. Why was this type of glue used?

____

____

11. Why is a washer placed under each of the round head wood screws used to hold the door part in place?

____

____

END OF LESSON 16

PROJECT EVALUATION FOR THE BUILDING CONSTRUCTION 12 BIRDHOUSE PROJECT

Item	What to look for	possible marks	project mark
1. Dimensions	-are the dimensions exactly as they should be -are there slight errors -are there wrong dimensions	20	
2. Peg	-was it installed -is it neatly done -is it in a practical position	4	
3. Dripcuts	-were they put in -were they in the proper location	4	
4. Joints	-does the birdhouse fit together well -is it drafty -does it leak	10	
5. Cleats	-were they properly installed	4	
6. Recessed floor	-was this properly done	2	
7. Drain holes	-were they put in -are they in the correct location	3	
8. Vents	-were they put in -are they in the correct location	3	
9. weatherstrip	-was it installed	3	
10. Paint	-is the paint the correct type -is the project the correct color	5	
11. Glue	-was the glue suitable for outdoor applications	4	
12. Construction details	-is the project securely fastened together -does the roof slope -does the roof overhang -does the project look good -are the proper fasteners used -was the project sanded smooth before finishing	15	
13. Plans and Writeup	-are the plans well done -is there a complete writeup	20	
14. Fasteners	-are they rustproof -are they properly installed	3	
		100	

FROM

FILE NO.

BUILDING CONSTRUCTION 12
PROJECT
(LESSON 16)

ALBERTA
CORRESPONDENCE
SCHOOL,
BOX 4000
BARRHEAD,
ALBERTA
TOG 2PO

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ______

Time Spent on Lesson ______

(If label is missing or incorrect)

File Number ______

Lesson Number ______

FOR SCHOOL USE ONLY

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Lesson Grading: ______

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TRADE MATHEMATICS III

Division
Conversion problems
Square root
The Theorem of Pythagoras

INTRODUCTION

In Lesson 13 we discussed multiplication and its applications. In this lesson we will be discussing division, finding square roots, plus various applications of these procedures.

Division is the inverse operation of multiplication. This means that it 'undoes' what multiplication 'does'. Thus, the procedures of division have a relationship to the procedures of multiplication, only in a reversed manner.

DIVISION

In division we find out how many times a numerical quantity, called the 'divisor', is in a second numerical quantity, called the 'dividend'. The number of times is the 'quotient' and if there is any part of the dividend which is smaller than the divisor, that part is the 'remainder'.

1. Division of Simple Numbers

Because division is the inverse operation of multiplication, we could find the quotient in a division problem using the reverse operation to multiplication.

Thus if we multiply $6 \times 7 = 42$

then we can say that 42 contains 7 quantities of 6 or 6 quantities of 7.

In division notation this becomes

$$6\overline{)42}^{\,7}$$

or

$$7\overline{)42}^{\,6}$$

In this division procedure, we must be able to look at 42 and realize that it can be represented by 6×7.

<u>In division, a thorough knowledge of multiplication tables is absolutely essential.</u>

SELF CORRECTING EXERCISE 1

Work through each division problem below, filling in the boxes as you go along.

1.

```
      1□□
23 ) 3562
     23xx
     □2□
     115
      1□2
       9□
       □□
```

2.

```
          □7□
103 ) 100620
       □27xx
        □9□
        70□
         □□0
         60□
          □□
```

3.

```
      □0□
52 ) 5356
     □□xx
      15
       0
      156
      □□□
        0
```

Now do the following division questions on your own.

4. $32\overline{)3392}$

5. $121\overline{)42350}$

6. $20\overline{)36547}$

7. $191\overline{)6971}$

8. $805\overline{)7317}$

2. Division of Decimal Numbers

If the dividend (number you are dividing into) is a decimal rather than a whole number, your answer will also be a decimal. The decimal point in the answer will appear directly above the decimal point in the dividend. Once you have placed the decimal point in the answer you can go ahead and divide as before.

EXAMPLE: Divide 161.92 by 32.

32)161.92 DECIMAL POINTS LINE UP	Begin by placing the decimal point where it will appear in the answer.
5. 32)161.92 160 1	32 divides into 161 about 5 times. Place this partial quotient 5 above the last digit in 161. (It is very important that the 5 is placed correctly. Otherwise, the decimal point will be in the wrong place in the answer.) Multiply 32 by 5 and subtract this product from 161.
5.0 32)161.92 160 19 0 19	Bring down the 9. 32 divides into 19 zero times. Place this partial quotient 0 above the 9 in the dividend. Multiply 0 and 32 to get 0. Subtract 0 from 19.
5.06 32)161.92 160 19 0 192 192 0	Bring down the 2. 32 divides into 192 6 times. Place this partial quotient 6 above the last digit in the dividend. Multiply 6 and 32 and subtract this product from 192. The division is complete. The quotient is 5.06. (Note that the quotient has the same number of decimal places as the dividend.)
161.92 ÷ 32 = 5.06	

In some division questions, you will have to insert zeros to act as placeholders between the decimal point and the first digit in the quotient.

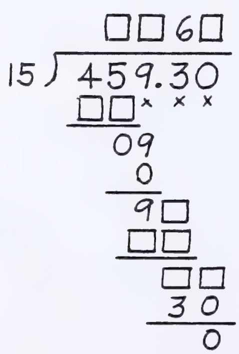
EXAMPLE: Divide 1.28 by 320.

. 320)1.28 LINE UP DECIMAL POINTS	Place the decimal point in the answer above the decimal point in the dividend. Note that 320 will not divide into 128.
. 4 320)1.280	Add one zero to 1.28. Divide 320 into 1280. It goes 4 times. Place the quotient 4 above the last digit in 1280.
. 4 320)1.280 1 280 0	Multiply 4 and 320 and subtract this product from 1280.
.004 320)1.280 1 280 0	Insert two zeros between the decimal point and the quotient, 4. These zeros represent tenths and hundredths.
1.28 ÷ 320 = 0.004	

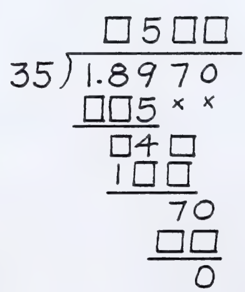
SELF CORRECTING EXERCISE 2

Begin by placing the decimal point in the quotient in its proper position above the decimal point in the dividend. Then, work through each division question, filling in the blanks as you go along.

1.



2.



Now do the following division questions on your own. Make sure that the decimal point is placed correctly in your answer.

$136\overline{)7.072}$ $21\overline{)253.89}$

$230\overline{)11.5}$ $234\overline{)0.7254}$

If the divisor (number you are dividing by) is a decimal rather than a whole number, you will have to change it to a whole number before you can divide. This can be done by moving the decimal point in the divisor to the right so that it appears after the last digit in the divisor. A mark called a carat ($\wedge$) is used to indicate the new position of the decimal point.

Since the decimal point has been moved to the right in the divisor, it must be moved the same number of places to the right in the dividend. A carat is also used in the dividend to indicate the new position of the decimal point. The decimal point in the answer will appear above the caret in the dividend.

EXAMPLE: Divide 7.5 by 0.25.

$\overset{.}{}$ $0.25_\wedge\;\overline{)\,7.50_\wedge}$	To make the divisor a whole number, you must move the decimal point two places to the right. Place a caret after the 5 in the divisor. In order to move the decimal point two places to the right in the dividend, you must add a zero. Place a caret after the 0 in the dividend. Insert a decimal point above the caret in the dividend.
$3.$ $0.25_\wedge\;\overline{)\,7.50_\wedge}$ $\underline{7\,5}$ 0	25 goes into 75 three times, with no remainder. Place the quotient 3 above the last digit in 75. Multiply 3 and 25 to obtain a product of 75. Division is complete since the remainder is 0 and there is only a 0 left to bring down.
$30.$ $0.25_\wedge\;\overline{)\,7.50_\wedge}$ $\underline{7\,5}$ 0	Insert a zero after the 3 to hold the place of the ones.
$7.5 \div 0.25 = 30$	

SELF CORRECTING EXERCISE 3

1. $0.13\,\overline{)\,52}$

2. $1.5\,\overline{)\,0.4005}$

3. $0.315 \overline{)1.9845}$

4. $0.93 \overline{)0.05208}$

5. $6.31 \overline{)11.24442}$

6. $50.1 \overline{)857.211}$

7. $6.332 \overline{)9687.96}$

8. $0.437 \overline{)2351.5}$

There is one more type of division which can usually be done mentally. This is the division by 10 and its multiples.

EXAMPLE: 69.31 ÷ 10

$$
\begin{array}{r}
6.931 \\
10 \overline{)69.31} \\
\underline{60} \\
9\,3 \\
\underline{9\,0} \\
31 \\
\underline{30} \\
10 \\
\underline{10}
\end{array}
$$

Notice that our quotient has the same numerals in the same order as in the dividend. The only difference is that the decimal point has been moved one place to the left.

If we were to divide by 100 we would find our decimal point moves two places to the left.

If we were to divide by 0.1 we would find our decimal point moves one place to the right.

SELF CORRECTING EXERCISE 4

Perform the following divisions by relocating the decimal point.

(a) $171.91 \div 100 =$ (b) $698.317 \div 1000 =$

(c) $87.92 \div 0.01 =$ (d) $12.3 \div 0.001 =$

(e) $17.31 \div 1000 =$ (f) $1.3 \div 1000 =$

3. Division of Fractional Numbers

Suppose were were asked to divide 3 by $\frac{1}{4}$. What are we really saying?

We are really asking,

How many $\frac{1}{4}$ sized units are there in 3 whole units?

If our divisor is $\frac{1}{4}$ of a unit, there msut be 4 of these units in each whole, and if we have 3 whole units, there must be 3×4 or 12 of the $\frac{1}{4}$ sized units in those 3 whole units.

So our division problem $3 \div \frac{1}{4}$

has become $3 \times 4 = 12$

When we divide by a fractional value, we invert the divisor and multiply, following the rules of multiplication of fractional values.

SELF CORRECTING EXERCISE 5

(a) $\frac{3}{8} \div \frac{1}{3} =$

$= \frac{3}{8} \times \frac{3}{1}$

$= \frac{9}{8}$

$= 1\frac{1}{8}$

(b) $\frac{5}{16} \div \frac{1}{3} =$

(c) $\frac{1}{8} \div \frac{1}{3} =$

(d) $\frac{9}{16} \div \frac{1}{5} =$

(e) $\frac{7}{8} \div \frac{1}{5} =$

(f) $\frac{1}{4} \div \frac{1}{16} =$

When we have a fraction such as $\frac{12}{16}$, we can express this fraction by cancelling common factors in both numerator and denominator.

$$\frac{12}{16}$$

$$= \frac{2 \times 2 \times 3}{2 \times 2 \times 2 \times 2}$$

$$= \frac{3}{2 \times 2}$$

$$= \frac{3}{4}$$

In actual fact we are dividing both numerator and denominator by the same factor. In this case it is 4.

If we are multiplying or dividing fractions, we can also cancel common factors in both numerator and denominator, using both fractions, so long as we are doing multiplication.

EXAMPLE:

Perform the following division.

$$\frac{15}{16} \div \frac{3}{4}$$

$$= \frac{15}{16} \times \frac{4}{3}$$

$$= \frac{3 \times 5 \times 4}{4 \times 4 \times 3}$$

$$= \frac{5}{4}$$

$$= 1\frac{1}{4}$$

SELF CORRECTING EXERCISE 6

Perform the following divisions

(a) $\frac{3}{4} \div \frac{1}{8} =$

(b) $\frac{7}{8} \div \frac{1}{2} =$

(c) $\frac{3}{16} \div \frac{3}{8} =$

(d) $\frac{3}{4} \div \frac{3}{4} =$

4. Division of Mixed Numbers

A mixed number is the indicated sum of a whole number and a fraction, and when we divide one mixed number, by another mixed number, we convert both mixed numbers to fractions and then follow the rules for division by fractions.

EXAMPLE:

Perform the following division.

$2\frac{7}{8} \div 3\frac{1}{4}$

$2\frac{7}{8} = \frac{23}{8}$

$3\frac{1}{4} = \frac{13}{4}$

So we have $\frac{23}{8} \div \frac{13}{4}$

$$= \frac{23}{8} \times \frac{4}{13}$$

$$= \frac{23 \times 1}{2 \times 13}$$

$$= \frac{23}{26}$$

If the quotient is an improper fraction, always convert it to a mixed number. An improper fraction is one in which the numerator is greater than the denominator.

SELF CORRECTING EXERCISE 7

Perform the following divisions.

(a) $1\frac{1}{4} \div \frac{5}{8}$

(b) $1\frac{1}{2} \div 2\frac{1}{4}$

(c) $1\frac{1}{2} \div 3$

(d) $2\frac{7}{16} \div 1\frac{5}{8}$

(e) $4\frac{1}{8} \div 1\frac{3}{8}$ (f) $15\frac{3}{8} \div 5\frac{1}{8}$

CONVERSION PROBLEMS

So far, in these mathematics lessons, we have discussed decimal quantities and fractional quantities separately. Let us consider the relationship between these two systems of meansurement.

1. Decimals to Fractions

First, let us convert decimal values into fractional values.

If we are given the quantity 0.3, this is read as 'three tenths'. It actually means three of the ten equal sized parts.

Three of ten equal sized parts is the way we would read the fraction $\frac{3}{10}$, which is also read 'three tenths'.

Thus $0.3 = \frac{3}{10}$

Similarly $0.41 = \frac{41}{100}$

and $0.269 = \frac{269}{1000}$

> Any decimal quantity can be written as a fraction. The numerator of this fraction is the decimal quantity and the denominator is a multiple of 10, which contains the same number of zeros as there are digits in the decimal quantity.

When we write our fraction, we can of course, cancel common factors in the same way as we can in any other fraction.

EXAMPLE:

Convert the following decimal value to a fraction.

0.75

$$= \frac{75}{100}$$

$$= \frac{5 \times 5 \times 3}{5 \times 5 \times 4}$$

$$= \frac{3}{4}$$

SELF CORRECTING EXERCISE 8

Convert the following decimal values to fractional values.

(a) 0.919 (b) 17.315

(c) 0.125 (d) 0.3125

(e) 0.625 (f) 0.875

(g) 0.4325 (h) 0.6875

2. Fractions to Decimals

In defining a fractional value, we say that the denominator is the number of equal-sized parts into which the whole was divided, and the numerator is the number of those parts.

Thus if we write $\frac{3}{4}$, we mean we are taking three out of four equal sized parts of some whole.

If we divide the numerator 3 by, the denominator 4, we will get the following calculation.

$$\begin{array}{r} .75 \\ 4\overline{)3.0} \\ \underline{2\,8} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

We found in the last section that $0.75 = \frac{3}{4}$. Now we have found that this form of division will give us the decimal equivalent of $\frac{3}{4}$.

SELF CORRECTING EXERCISE 9

Find the decimal equivalent of the following fractions.

(a) $\frac{1}{2}$

(b) $\frac{1}{4}$

(c) $\frac{3}{8}$

(d) $\frac{1}{8}$

(e) $\frac{3}{16}$

(f) $\frac{9}{16}$

(g) $\frac{11}{16}$ (h) $\frac{13}{16}$

SQUARE ROOT

1. Simple Squares

What do we mean by the word square?

In geometry a square is a figure with 90° angles and four sides of equal length. To find the area of such a figure, we could multiply the length by the width. But as these two dimensions are the very same value for any one square, in effect we must multiply the length by itself.

In arithmetic when we multiply a value by itself, we can write the value as a^2, and we say it is the value 'a squared'. Notice that the value of a^2 is the area of a square with one side having a length of 'a' units.

Any number can be squared, and the whole numbers have squares that are also whole numbers.

EXAMPLE:

Find the square of 4

$4^2 = 4 \times 4 = 16$

SELF CORRECTING EXERCISE 10

Find the squares of the following numbers.

(a) $3^2 = 3 \times 3 =$ (b) $5^2 = 5 \times 5 =$

(c) $7^2 =$ (d) $8^2 =$

(e) $9^2 =$ (f) $10^2 =$

(g) $12^2 =$ (h) $15^2 =$

When we reverse the basic procedure, we say that we are finding the square root of a number. In effect, we are finding two factors, each exactly the same value, whose product is the given number. The simplest way to indicate this procedure is with a 'radical sign', made like this

Thus $\sqrt{16}$ means 'the square root of 16'.

From our previous example we found that

$4^2 = 16$

That is $4 \times 4 = 16$

So we can now write $\sqrt{16} = \sqrt{4 \times 4} = 4$

SELF CORRECTING EXERCISE 11

Find the square root of the following numbers

(a) $\sqrt{4} =$ (b) $\sqrt{9} =$

(c) $\sqrt{36} =$ (d) $\sqrt{49} =$

(e) $\sqrt{100}$ =   (f) $\sqrt{121}$ =

(g) $\sqrt{144}$ =   (h) $\sqrt{256}$ =

2. Square Root by Division

The method above works very well as long as we know the numbers involved and can recognize that 25 is 5 × 5 so that $\sqrt{25} = 5$.

What do we do with a number that is much larger than that?

There are several methods of finding the square roots of these numbers. In this lesson you will learn one method, which is called the division method. This method can be used with any whole value and requires only skill in division to complete the calculations. For fractional values, find the square root of both numerator and denominator.

Finding the square root of a number by division involves two steps:

1. Separating the numeral into groups of two digits starting from the DECIMAL POINT.

2. Calculation of the square root.

Step 1: Separation.
Starting at the RIGHT separate the number into groups of two digits.
A number with an EVEN number of digits will have two digits in each group.

e.g.

$\sqrt{1024}$	$\sqrt{163216}$	$\sqrt{64}$
10 24	16 32 16	64

A number with an ODD number of digits will have one digit in the left hand group.

e.g.

$\sqrt{289}$	$\sqrt{35721}$	$\sqrt{9}$
2 89	3 57 21	9

one digit in the left hand group

Step 2: Calculation

Example #1: Calculate $\sqrt{1024}$

Step 1: Separate the number into groups of two digits.

```
10      24
```

Step 2: Calculate:

a. The largest square root for 10 is 3. $3 \times 3 = 9$. Place the 3 directly <u>above</u> the digit 0. Place 9 under 10. Subtract.

```
   3
  |10      24
  | 9
  | 1
```

b. Bring down the 24

```
   3
  |10      24
  | 9
  |124
```

c. Double the quotient. $3 \times 2 = 6$ Place 6 in front of the new dividend 124 leaving a blank space.

```
   3  <-------- QUOTIENT
  |10      24
  | 9
6_|124
```

d. Use 6 as a trial divisor into 12. The quotient is 2. Place 2 above the digit 4 and <u>also in the blank space beside the 6.</u>

```
   3       2
  |10      24
  | 9
62|124
```

e. Multiply $62 \times 2 = 124$ Write 124 under the 124. Subtract. There is no remainder.

```
   3       2
  |10      24
  | 9
6 |124
  |124
```

$\sqrt{1024} = 32.$ check: $32 \times 32 = 1024$

SELF-CORRECTING EXERCISE 12

Find the square root of the following values, using the division method.

(a) $\sqrt{961}$ (b) $\sqrt{729}$

(c) $\sqrt{1936}$ (d) $\sqrt{7209}$

THE THEOREM OF PYTHAGORUS

1. The Theorem

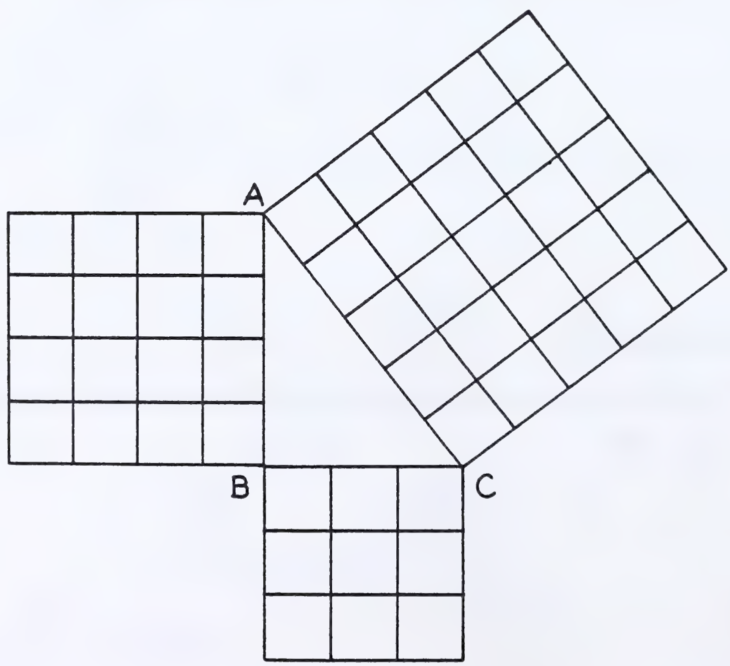
This theorem is only applicable to a right triangle.

A Right Triangle is any triangle in which one angle is a right angle.

The Hypotenuse of a right triangle is that side which is opposite to the right angle.

Pythagorus, who actually lived in Ancient Greek times, observed a remarkable relationship between the sides and the hypotenuse of a right triangle.

This relationship can be illustrated by the following diagram.



In this diagram we have $\triangle ABC$ with a right angle at point B.

We have constructed a square on each of the three sides of this triangle. If we observe the areas of these three squares, we can see that $25 = 16 + 9$.

This basically is the Theorem of Pythagorus.

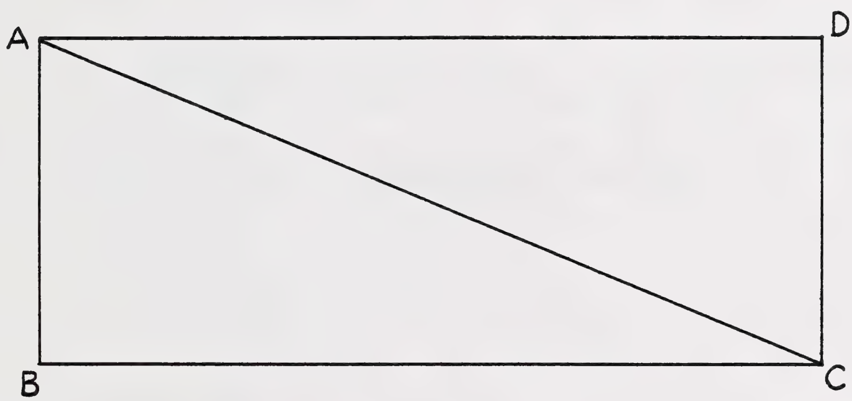
> In any Right Triangle, the square on the Hypotenuse is equal to the sum of the squares on the other two sides.

2. Application of the Theorem

First, let us consider a rectangle.

> A Rectangle is a four sided plane figure having all its interior angles right angles.

If we have a rectangle, and draw in one of the two diagonals, we then have two right triangles, as in the following diagram.



We have constructed the rectangle ABCD, with a length of 12 cm and a width of 5 cm and we have drawn the diagonal $\overline{AC}$. This divides the figure into two right triangles $\triangle ABC$ and $\triangle ADC$.

If we want to calculate the length of $\overline{AC}$, we can use the Theorem of Pythagorus.

Length of $\overline{AB}$ is 5 cm

$$5^2 = 25$$

Length of $\overline{BC}$ is 12 cm

$$12^2 = 144$$

$$25 + 144 = 169$$

$$\sqrt{169} = 13$$

So. we have calculated the length of $\overline{AC}$ to be 13 cm.

If you will measure $\overline{AC}$ you will find this calculation to be correct.

SELF CORRECTING EXERCISE 13

Find the length of the missing side in each of these right triangles.

(a) Side is 24 m, side 7 m

Hypotenuse is ______________

(b) Side is 40 m, side is 9 m

Hypotenuse is ______________

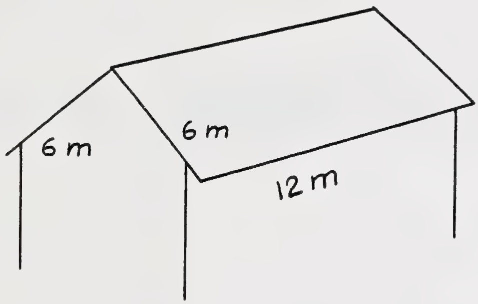
(c) Find the length of a diagonal of a rectangle whose sides are 60 cm and 11 cm.

(d) A diagonal of a rectangle is 85 cm. The one side measures 84 cm. Find the length of the other side of the rectangle.

EXERCISE 1

Complete the following questions and send them in for correction. Show your calculations. Use diagrams to help you answer the questions correctly.

1. A gable roof is 12 m long and each rafter is 6 m long. How many sheets of plywood (metric plywood is 1200 mm × 2400 mm) will totally cover this roof?



2. If a cement truck carries 6 m^3 of concrete, how many loads would be needed to pour a sidewalk 100 m long, 1.25 m wide and 10 cm thick?

3. A carpenter has a board which is 292 mm wide. He wants to cut a number of strips each 57 mm wide and each saw cut wastes 3 mm. How many strips can he cut from this board?

4. A stack of 16 mm plywood stands 1.96 m high. How many sheets are in that stack?

5. A planing machine can be set to remove 4 mm per stroke. How many strokes would be necessary to reduce a board from 86 mm to 67 mm?

6. A farmer builds a granary which is 4 m square. How high will he have to fill this granary to have 3000 dm^3 in it?

7. A box with a lid is made of wood 2 cm thick. If the outside dimensions are 1 m × 2 m × 4.4 m, find the inside volume of the box.

8. A building is 10 m wide. The gable roof rises 2.5 m to the peak. Calculate the length of the rafters if you allow 50 cm for the eaves?

9. A contractor has to build a wall 8.5 m by 2.8 m using stone blocks. If the face of each block measures 400 by 200 mm, find the number of blocks he will need.

10. A homeowner wishes to make an ornamental wall at one end of her living room, using vertical, grooved planks. If the wall is 4 m wide and each plank measures 16 cm wide, how many planks will she need?

11. (a) A contractor requires a chimney that is 9 m high. If each brick uses 60 mm of depth, including mortar, how many layers of brick will he need?

(b) If each layer contains 6 bricks, how many bricks will be needed for the chimney?

12. (a) A contractor wishes to put a series of windows into the wall of an office building. If the wall measures 5 m and each window measures 111 cm how many windows will he need?

(b) What wall space will be left after the windows are installed?

13. A man wants to build a picket fence around his back yard. The fence will extend 15 m back from his house. The lot is 20 m wide and the house 15 m wide. Each picket is 60 mm wide and will spread 40 mm. How many pickets will he need?

Answers to Self-Correcting Exercises

S.C.E. 1 -	(1)154 R 20 (2) 976 R 92 (3) 103 (4) 106 (5) 350, (6) 1827 R7 (7) 36 R 95 (8) 9 R 72
S.C.E. 2 -	(1)30.62 (2) 0.0542, 0.052, 12.09, 0.05, 0.0031
S.C.E. 3 -	(1) 400, (2) 0.267, (3) 6.3, (4) 0.056, (5) 1.782, (6) 17.11 (7) 1530, (8) 5381.0068
S.C.E. 4 -	(a) 1.7191, (b) 0.698317, (c) 8792, (d) 12300, (e) 0.01731, (f) 0.0013
S.C.E. 5 -	(b)15/16 (c) 3/8 (d) 2 13/16, (e) 4 3/8, (f) 4
S.C.E. 6 -	(a) 6, (b) 1 3/4
S.C.E. 7 -	(b) 2/3, (c) 1/2, (d) 3/2, (e) 3, (f) 3
S.C.E. 8 -	(a) 919/1000, (b) 17 63/200, (c) 1/8, (d) 5/16, (e) 5/8, (f) 7/8, (g) 173/400, (h) 11/16
S.C.E. 9 -	(a) 0.5, (b) 0.25, (c) 0.375, (d) 0.125, (e) 0.1875, (f) 0.5625, (g) 0.6875, (h) 0.8125
S.C.E. 10 -	(a) 9, (b) 25 (c) 49, (d) 64, (e) 81, (f) 100, (g) 144, (h) 225
S.C.E. 11 -	(a) 2, (b) 3, (c) 6, (d) 7, (e) 10, (f) 11, (g) 12, (h) 16
S.C.E. 12 -	(a) 31, (b) 27, (c) 44, (d) 84.9
S.C.E. 13 -	(a) 25 m, (b) 41 m, (c) 61 cm, (d) 13 cm.

END OF LESSON 17

BUILDING CONSTRUCTION 12

HOW YOUR FINAL MARK WILL BE DETERMINED

All students registered in Building Construction 12 who have completed at least **eighteen** lessons plus the practical work assignment will have their course mark evaluated as indicated below. The evaluation is out of 100 percent.

Practical Work	-	25 percent
Lessons	-	15 percent
Final Exam	-	60 percent
Total	-	100 percent

NOTE: If your mark on the final test is less than 40%, **no consideration** will be given for your year's work. Your final course mark will then be based entirely on the final test.

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________

Time Spent on Lesson ____________

(If label is missing or incorrect)

File Number ____________

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received: ________

Lesson Recorded ________

Student's Questions and Comments

Apply Lesson Label Here

Name ________

Address ________

____

____

Postal Code ________

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

TRADE MATHEMATICS IV

Ratio
Proportion
Percentages

RATIOS

> A RATIO compares two numbers by division. It compares like objects.

EXAMPLE 1:

For every $20 Peter spends on nails, William spends $30.

(a) Ratio: $\frac{20}{30}$ (This is read 'twenty over thirty'.)

Explanation: This expresses the ratio of the amount Peter spends on nails to that which William spends.

(b) Ratio: $\frac{30}{20}$ (This is read 'thirty over twenty'.)

Explanation: This is the ratio of the amount William spends on nails to that which Peter spends.

EXAMPLE 2:

In a contest, John hits 4 nails into a board in the same time that Henry hits 6 nails into a board.

(a) Ratio: $\frac{4}{6}$ (This is read 'four over six'.)

Explanation: This expresses the ratio of the number of nails hit into a board by John to those hit by Henry.

(b) Ratio: $\frac{6}{4}$ (This is read 'six over four'.)

Explanation: This expresses the ratio of the number of nails hit into a board by Henry to those hit by John.

PROPORTIONS

1. What is a Proportion?

> A PROPORTION is an equivalent pair of ratios.

In a proportion, like $\frac{2}{3} = \frac{4}{6}$, we find that the products obtained by multiplying diagonally across the '=' are equal.

$\frac{2}{3} \quad \frac{4}{6}$ $\qquad$ $2 \times 6 = 12$, $3 \times 4 = 12$ We call these CROSS PRODUCTS.

Thus for our equivalent ratio $\frac{2}{3} = \frac{4}{6}$, the cross products are equal. (That is,

$2 \times 6 = 3 \times 4$ <u>or</u> $3 \times 4 = 2 \times 6$.)

Now let's consider two ratios which are not equivalent. (They do not form a proportion.)

$\frac{4}{5} \neq \frac{2}{3}$ $\qquad$ (The symbol '$\neq$' means 'is not equal to' or 'is not equivalent to'.)

We check the cross products.

$\frac{4}{5} \quad \frac{2}{3}$ $\qquad$ $4 \times 3 = 12$, $5 \times 2 = 10$

We see that the cross products are not equal. (That is, $4 \times 3 = 5 \times 2$ or $5 \times 2 \neq 4 \times 3$.)

From the previous examples, we arrive at the following:

<u>Tests for Proportions</u>

(a) If two ratios form a proportion, the cross products are equal.

(b) If the cross products of two ratios are equal, the ratios form a proportion.

(c) If two ratios do not form a proportion, their cross products are not equal.

(d) If the cross products of two ratios are not equal, the ratios do not form a proportion.

EXAMPLES:

Tell whether or not the following pairs of ratios are equivalent.

	RATIOS	CROSS PRODUCTS	CONCLUSIONS
(a)	$\frac{5}{3}, \frac{7}{4}$	$5 \times 4 = 20$ $3 \times 7 = 21$	These ratios are not equivalent. $\left(\frac{5}{3} \neq \frac{7}{4}\right)$
(b)	$\frac{15}{9}, \frac{10}{6}$	$9 \times 10 = 90$ $15 \times 6 = 90$	These ratios are equivalent. $\frac{15}{9} = \frac{10}{6}$

2. Finding the Missing Number in a Proportion

There are times when we are given a proportion with one part missing. It is then necessary to find the missing number using the information which is given. We use a variable (unknown) to hold the place of the missing number.

EXAMPLE:

Find the number which is missing in the proportion.

$$\frac{21}{14} = \frac{n}{6}$$ "n" is the variable used to replace the missing number.

Solution:

We use the cross products and division to find the value for n.

$$\frac{21}{14} = \frac{n}{6}$$

$14 \times n = 21 \times 6$ (since in any proportion, the cross products are equal.)

Now we divide both sides by the number which multiplies the variable. (In this case, we divide both sides by 14.)

$$\frac{\cancel{14}^{1} \times n}{\cancel{14}_{1}} = \frac{\cancel{21}^{3} \times \cancel{6}^{3}}{\cancel{14}_{\cancel{2}_{1}}}$$ We cancel factors common to the numerator and denominator of each fraction.

$1 \times n = 9$ — $1 \times n = n$, since 1 times any number leaves the number unchanged.

$$\boxed{n = 9}$$

Once we have found the missing number, we must check to see if it is the correct number. (Sometimes arithmetic errors can result in an incorrect answer.)

Check:

$$\frac{21}{14} = \frac{9}{6}$$ We put the value for "n" in the place which "n" held in the proportion.

$14 \times 9 = 126$
$21 \times 6 = 126$ They are the same!

Since the cross products are equal, 9 is the number for which we were looking.

SELF CORRECTING EXERCISE 1

1. Give an example of a ratio. ______________________

2. Give an example of a proportion. ______________________

3. Why is it a proportion? ______________________

4. Give an example which is not a proportion. ______________________

5. Why is it not a proportion? ______________________

3. Direct Proportion

EXAMPLE:

Compare the ratio of the times with the ratio of the distances travelled by an airplane moving at a constant speed of 200 kilometres per hour after 2 hours and 5 hours respectively.

The ratio of the times is $\frac{2}{5}$.

The distance travelled in 2 hours is 400 km.

The distance travelled in 5 hours is 1000 km.

The ratio of the distances in the same order is $\frac{400}{1000} = \frac{2}{5}$.

Therefore the ratio of the distances is equal to the ratio of the times. This relationship is a **direct proportion** since when the speed is constant the distance travelled by the airplane varies directly with the amount of time.

In the proportion above four measures are involved and are related, thus

$$\frac{400}{1000} = \frac{2}{5}$$

The numbers 400, 1000, 2 and 5 taken in this order are in proportion. Also if the four measures are known to be in direct proportion then as one ratio increases the second ratio increases at the same rate.

4. Inverse Proportion

Examine the following example to find out how the ratio of the speeds of two airplanes is realted to the ratio of their travelling time.

EXAMPLE:

Plane A travelled 840 km in 4 hours but plane B took 6 hours to travel the same distance.

The speed of plane A is $\frac{840}{4} = 210$ km/h.

The speed of plane B is $\frac{840}{6} = 140$ km/h.

$$\frac{\text{The speed of plane A}}{\text{The speed of plane B}} = \frac{210}{140} = \frac{3}{2}$$

$$\frac{\text{The time of plane A}}{\text{The time of plane B}} = \frac{4}{6} = \frac{2}{3}$$

If one of these ratios is inverted, then the inverted ratio will be equal to the other.

The speeds of the plane is inversely proportional to their travelling times or the travelling times of the planes is inversely proportional to the speeds.

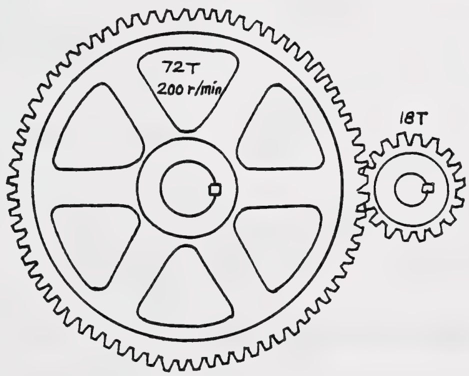
GEAR SPEEDS

Power from one rotating shaft to another can be transmitted by means of gears. The gear on the power shafted is called the **driver** and that on the other shaft, the **follower.**

The following example will illustrate the relationship between the speed of gears in mesh and the number of teeth on the gears respectively.

A driver with 72 teeth meshes with a follower of 18 teeth. If the speed of the driver is 200 r/min, find the speed of the follower.

Let the speed of the following be x.



The number of teeth of the driver passing the point of contact in 1 minute is 72×200.

The number of teeth of the follower passing the point of contact in 1 minute is $18 \times x$.

Therefore, $18x = 72 \times 200$.
Solving, we find that $x = 800$

Therefore, the speed of the follower is 800 r/min.

In this case, the driver-follower teeth ratio is $\frac{72}{18} = \frac{4}{1}$.

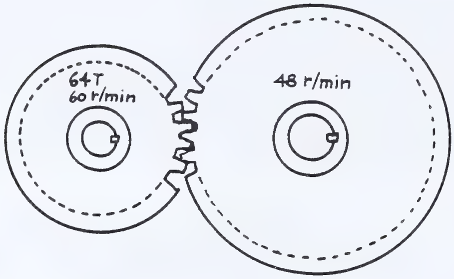
The driver-follower r.p.m. ratio is $\frac{200}{800} = \frac{1}{4}$.

This would indicate that when *two gears are in mesh, their speeds are inversely proportional to the numbers of their teeth.* It can be shown that this relationship is always true and be expressed as follows:

$$\frac{\textbf{R.P.M. of the follower}}{\textbf{R.P.M. of the driver}} = \frac{\textbf{Number of teeth on the driver}}{\textbf{Number of teeth on the follower.}}$$

EXAMPLE:

If a driving gear has 64 teeth and turns at 60 r/min, select a follower to give a speed of 48 r/min.



Solution:

Let the number of teeth on the follower be t.

The driver-follower teeth ratio is $\frac{64}{t}$.

The driver-follower speed ratio is $\frac{60}{48}$.

Therefore, $\frac{64}{t} = \frac{48}{60}$ ⟵ Note that one of these ratios has been inverted.

Solving, we find that t = 80.

Select a gear of 80 teeth for the follower.

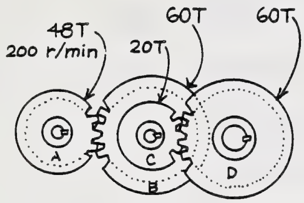
COMPOUND GEAR TRAINS

EXAMPLE:

A drive shaft rotating at 200 r/min has a gear with 48 teeth in mesh with a gear of 60 teeth on one end of a second shaft. On the other end of the second shaft is a gear with 20 teeth in mesh with a gear of 60 teeth on a third shaft. What is the speed at which the third shaft rotates? Such a multiple arrangement of gears is called a **compound gear train.**

Solution:

It is advisable to first draw a picture of the gear train.



The formula to use is:

$$\frac{\textbf{RPM of the follower gear}}{\textbf{RPM of the driver gear}} = \frac{\textbf{Number of teeth on the driver}}{\textbf{Number of teeth on the follower}}$$

Find out what speed gear B rotates at.

Therefore, $\dfrac{\text{RPM of gear B}}{200 \text{ r/min}} = \dfrac{48 \text{ T}}{60 \text{ T}}$

Solving, RPM of gear B $= 200 \text{ r/min} \times \dfrac{48 \text{ T}}{60 \text{ T}} = 160$ r/min.

Gear B and gear C would rotate at the same speed since they are on the same shaft.

RPM of gear B = RPM of gear C = 160 r/min.

To find out what speed the third shaft rotates one must know the speed gear D rotates.

Again using the above formula

$$\frac{\text{RPM of gear D}}{160 \text{ r/min}} = \frac{20 \text{ T}}{60 \text{ T}}$$

Solving, RPM of gear D $= 160 \text{ min}^{-1} \times \dfrac{20 \text{ T}}{60 \text{ T}} = 53$ r/min (to nearest revolution per minute)

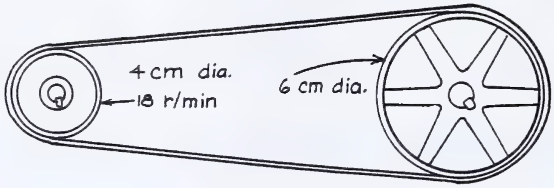
Therefore, the speed of the third shaft (gear D's shaft) must also be 53 r/min.

PULLEY SPEEDS

When power is transmitted by means of a belt or a chain, the speed of the follower shaft may be regulated by the sizes of the pulleys.

The following example will show the relationship between the speeds of two belted pulleys and their diameters.

A motor rotating at 1 800 r/min is belted to a grinder. If the pulley on the motor is 4 cm and the pulley on the grinder is 6 cm in diameter, find the speed of the grinder.



Motor Pulley **Grinder Pulley**

Let the speed of the grinder in r/min be x.

Then the belt speed of the motor in cm/min is $\pi \times 4 \times 1\ 800$.

Then the belt speed at the grinder in cm/min is $\pi \times 6 \times x$.

But the belt speed must be the same throughout.

Therefore, $4 \times \pi \times 1\ 800 = 6 \times \pi \times x$.

Solving we find that $x = 1\ 200$.

The speed of the grinder is 1 200 r/min.

In this case, the driver-follower diameter ratio is $\frac{4}{6} = \frac{2}{3}$

The driver-follower speed ratio is $\frac{1\ 800}{1\ 200} = \frac{3}{2}$.

This would indicate that *the speeds of the two belted pulleys are inversely proportional to their diameters.* It can be shown that this relationship is always true and may be expressed as follows:

$$\frac{\textbf{R.P.M. of follower pulley}}{\textbf{R.P.M. of driver pulley}} = \frac{\textbf{Diameter of driver pulley}}{\textbf{Diameter of follower pulley}}$$

EXAMPLE:

A 4 cm pulley turning at 200 r/min drives a 10 cm pulley. What is the speed of the 10 cm pulley?

Solution:

Let the speed of the 10 cm pulley be x.

The diameter ratio is 4:10.

The speed ratio in the same order is 200:x.

Therefore, $\frac{x}{200} = \frac{4}{10}$ ← Note that one of these ratios has been inverted.

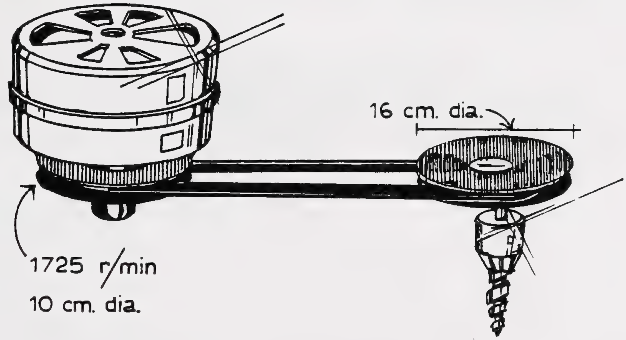
Solving we find that $x = 80$.
Therefore, the speed of the 10 cm pulley is 80 r/min.

SPEED OF BLADES AND DRILL BITS

Using a similar procedure as mentioned in the previous sections of this lesson, we can use ratios to calculate the speeds of cutting blades, drill bits, grinders and other tools where rotating motion is provided to a follower gear or pulley from a driver gear or pulley.

EXAMPLE:

A 12 mm steel drill bit is connected to a follower pulley 16 cm in diameter. A belt connects the follower pulley to a driver pulley of 10 cm diameter. An electric motor of 1725 r/min connects to the driver pulley. What speed does the 12 mm drill bit rotate at?



HINT: It would be helpful if a drawing is used to indicate how parts are connected. This reduces any confusion or possibility of errors occurring.

The formula to use for pulleys is:

$$\frac{\textbf{RPM of follower pulley}}{\textbf{RPM of driver pulley}} = \frac{\textbf{diameter of driver pulley}}{\textbf{diameter of follower pulley}}$$

So, $\frac{N \text{ r/min}}{1725 \text{ r/min}} = \frac{10 \text{ cm}}{16 \text{ cm}}$

$$N = 1725 \text{ r/min} \times \frac{10 \text{ cm}}{16 \text{ cm}}$$

$$= 1078 \text{ r/min}$$

The 12 mm drill bit will rotate at 1078 r/min since the drill chuck is directly connected to the follower pulley.

EXAMPLE:

A 20 cm diameter circular saw blade is connected to a follower pulley of 5 cm diameter. The follower pulley is connected via a belt to a driver pulley of 8 cm diameter. A continuous AC motor which rotates at 3450 r/min is directly connected to the driver pulley. What speed does the saw blade rotate at?

Again use the formula $\frac{\textbf{RPM of follower pulley}}{\textbf{RPM of driver pulley}} = \frac{\textbf{diameter of driver pulley}}{\textbf{diameter of follower pulley}}$

So $\dfrac{N \text{ r/min}}{3450 \text{ r/min}} = \dfrac{8 \text{ cm}}{5 \text{ cm}}$

$$N = 3450 \text{ r/min} \times \frac{8 \text{ cm}}{5 \text{ cm}}$$

$$= 5520 \text{ r/min}$$

The pulley rotates at 5520 r/min. Since the blade is directly connected to the pulley, the blade also rotates at 5520 r/min.

SELF CORRECTING EXERCISE 2

1. A remote controlled steel door can be opened and closed using a geared 2475 r/min motor. If the teeth ratio of the driver to the follower gear is 16 to 114, what speed does the follower gear rotate at?

2. A starter is used to start an engine. The starter's bendix gear has 10 teeth while the flywheel it meshes with has 140 teeth. If the flywheel is required to turn over at 100 r/min, what speed must the starter bendix rotate at?

3. A drill press uses a 1750 r/min motor to provide power to its drill chuck. If the motor pulley is 8 cm in diameter, what diameter must the drill chuck pulley be if it is to rotate at 550 r/min?

4. The follower pulley on a bandsaw is 18 cm in diameter. A 3450 r/min motor uses a 6.5 cm diameter pulley to provide power. What speed will the follower pulley rotate at?

PERCENTS

1. Definition of Percent

PERCENT means 'per hundred'. A percent is a ratio with a denominator of 100. We commonly use the symbol '%'to mean 'with a denominator of 100'. We refer to '%' as the percent symbol.

EXAMPLES:

$\frac{15}{100}$ can also be written as 15%.

(We read '15%' as 'fifteen percent'.)

275% (two hundred seventy-five percent) is the same as $\frac{275}{100}$.

100% (one hundred percent) is the same as $\frac{100}{100}$.

By studying the above examples, we see that:

1. A ratio whose value is less than 1 is represented by a percent which is less that 100%.
2. A ratio whose value is 1 is represented by 100%.
3. A ratio whose value is greater than 1 is represented by a percent which is greater than 100%.

2. Changing a Percent to a Decimal Number

EXAMPLE:

Change 56% to a decimal number.

Solution

$56\% = \frac{56}{100}$ ⟵ We can write the percent in ratio form.

$\frac{56}{100} = 0.56$

Thus we have found that 56% = 0.56.

We can summarize the above procedure as follows:

To change a percent to a decimal number, we:

1. Write the percent in ratio form (with a denominator of 100).
2. Change this ratio to a decimal.

EXAMPLES:

(a) $27\% = \frac{27}{100} = 0.27$

(b) $13.5\% = \frac{13.5}{100} = 0.135$

(c) $4\% = \frac{4}{100} = 0.04$ (We must use a zero placeholder. Otherwise, we cannot move the decimal point 2 places to the left.)

(d) $298\% = \frac{298}{100} = 2.98$

3. Changing a Decimal Number to a Percent

EXAMPLE:

Change 0.613 to a percent.

Solution

$$0.613 = \frac{613}{1000}$$

(Denominator is 1000 since the 3 is in the thousandths place.)

$$= \frac{61.3 \div 10}{1000 \div 10}$$

(We divide both terms by 10, so we will have a denominator of 100.)

$$= \frac{61.3}{100}$$

$$= 61.3\%$$

When doing problems of this type, we do not normally show all these steps. We shorten the method to the form in the box below.

> To change a decimal number to a percent, we:
>
> 1. Move the decimal point two places to the right and give the number a denominator of 100.
>
> 2. Rewrite the ratio in % form.

EXAMPLES:

(a) $0.625 = \frac{62.5}{100} = 62.5\%$

(b) $0.003 = \frac{0.3}{100} = 0.3\%$

(c) $1.2 = \frac{120}{100} = 120\%$ (A zero placeholder is used, so we can move the decimal two places to the right.)

(d) $0.32 = \frac{32}{100} = 32\%$

4. Changing a Fraction to a Percent

We have 2 possible choices of methods for changing a fraction into a percent.

EXAMPLE:

Change $\frac{3}{8}$ into a percent.

Solution:

METHOD 1: (PROPORTION)

$$\frac{3}{8} = \frac{?}{100}$$

(1) If we can find the numerator when the denominator is 100, then we can find the percent. We can use a proportion with a variable to find the numerator.

$$\frac{3}{8} = \frac{n}{100}$$

$$8 \times n = 3 \times 100$$

$$\frac{8 \times n}{8} = \frac{3 \times 100}{8}$$

$$n = \frac{75}{2}$$

$$n = 37.5$$

(2) From the proportion, we have found the percent.

$$\frac{3}{8} = \frac{37.5}{100}$$

So $\frac{3}{8} = 37.5\%$

METHOD 2 (FRACTION TO DECIMAL TO PERCENT)

(1) We change $\frac{3}{8}$ to the equivalent decimal number by dividing the denominator, 8, into the numerator, 3.

$$\begin{array}{r} .375 \\ 8\overline{)3.000} \\ \underline{2\,4} \\ 60 \\ \underline{56} \\ 40 \\ \underline{40} \end{array}$$

So $\frac{3}{8} = 0.375$

(2) Change the decimal number to a percent.

$\frac{3}{8} = \frac{37.5}{100} = 37.5\%$

Thus $\frac{3}{8} = 37.5\%$

Thus we summarize the two methods as follows:

> To change a fraction to a decimal, we:
>
> 1. Use a proportion with a variable for the unknown percent.
>
> (OR)
>
> 2. Change the fraction to a decimal number. Then change the decimal number to a percent.

Which method should you choose? Choose the method which is easier for you.

SELF CORRECTING EXERCISE 3

Change the following percents from ratio form to % form or vice versa.

1. $\frac{47}{100} =$ 2. 62% =   3. 14% =

4. $\frac{106}{100} =$

5. 875% =

6. $\frac{27}{100} =$

SELF CORRECTING EXERCISE 4

Write the following in % form.

1. 5.28 =
2. 68.3 =
3. 359 =
4. 0.07 =
5. 42.37 =
6. 0.38 =

SELF CORRECTING EXERCISE 5

For each of the following, change the percent to a decimal number.

1. 193% = $\frac{}{100}$ = ______
2. 6% =
3. 16.8% =
4. 63% =
5. 94% =
6. 8.32% =

PERCENTAGE PROBLEMS

1. Setting Up Basic Percentage Problems

In problems involving percents, we have three basic variable elements from which we set up the proportion.

$$\boxed{\frac{a}{b} = \frac{r}{100}}$$

The three variable elements in the proportion are defined as follows:

a(amount) -	This is the number or the quantity which is to be compared. (It is the numerator of the first ratio.)
b(base) -	This is the number we are comparing to. (It is the denominator of the first ratio.)
r(rate) -	This is the number part of the percent. (Together with the denominator of 100, this forms the second ratio.)

Using the proportion $\frac{a}{b} = \frac{r}{100}$, we are able to find the missing quantity when the other two quantities are given. From this we gather that there are only three types of problems involving percents:

1. those in which the amount is unknown;
2. those in which the base is not given; and
3. those in which the rate is not given.

The missing quantity is found by solving the proportion.

EXAMPLE 1:

(a) What is 25% of $444?

Solution

We must first identify a, b, and r. In general, we find that all percent problems can be changed into the sentence.

$\boxed{\text{a is r \% of b.}}$ The base is usually preceded by the word "of."

In this case, we have

$ ______ is 25% of $444.
a r b

We now use the information in the proportion

$$\frac{a}{b} = \frac{r}{100}$$

Substituting for b and r, we get

$$\frac{a}{444} = \frac{25}{100}.$$

Since the percent is less than 100%, the amount must be less than the base. (i.e., each numerator must be smaller than the corresponding denominator.)

Now solve the proportion for a.

$$a \times 100 = 444 \times 25$$

$$\frac{a \times \cancel{100}^{1}}{\cancel{100}_{1}} = \frac{\cancel{444}^{111} \times \cancel{25}^{1}}{\cancel{100}_{\cancel{4}\,1}}$$

$$a = 111$$ ← Note: a is less than b, since \$111 is less than \$444.

Thus, \$111 is 25% of \$444.

Now try this one yourself.

(b) What is 23% of 87?

Solution

________ is ________ % of ________.

a r b

EXAMPLE 2:

(a) What percent of 19.50 is 130? (Round the answer to the nearer tenth of one percent.)

Solution

$\underset{a}{130}$ is $\underset{r}{\_\_\_\_\_\_}$ % of $\underset{b}{19.50}$

$$\frac{130}{19.50} = \frac{r}{100}$$

Since the amount is larger than the base, r will be more than 100%. (That is, each numerator is larger than its corresponding denominator).

$$19.50 \times r = 130 \times 100$$

$$\frac{\cancel{19.50}^{1} \times r}{\cancel{19.50}_{1}} = \frac{\cancel{130}^{10} \times \cancel{100}^{2}}{\cancel{19.50}_{\cancel{0.39}\ 0.03}}$$

$$r = \frac{20}{0.03} = \frac{2000}{3}$$

$$r = 666.66$$

Note: r is greater than 100, since 666.7 is greater than 100.

r = 666.7 (rounded to the nearer tenth of one percent.)

So, 130 is 666.7% of 19.50.

Now try this one on your own.

(b) What percent of 416 is 520?

Solution

$\underset{a}{\underline{\qquad\qquad}}$ is $\underset{r}{\underline{\qquad\qquad}}$% of $\underset{b}{\underline{\qquad\qquad}}$.

EXAMPLE 3:

(a) $113\frac{3}{4}$ is $62\frac{1}{2}$% of what number?

Solution

$\underset{a}{\underline{113\frac{3}{4}}}$ is $\underset{r}{\underline{62\frac{1}{2}}}$% of $\underset{b}{\underline{\qquad\qquad}}$.

$$\frac{113\frac{3}{4}}{b} = \frac{62\frac{1}{2}}{100}$$

$$b \times 62\frac{1}{2} = 113\frac{3}{4} \times 100$$

We must change the mixed numbers into improper fractions before multiplying or dividing.

$$\frac{b \times \cancel{\frac{125}{2}}^{1}}{\cancel{\frac{125}{2}}_{1}} = \frac{\frac{455}{4} \times 100}{\frac{125}{2}}$$

$$b = \frac{\frac{455 \times 100}{4}}{\frac{125}{2}}$$

$$b = \frac{455 \times 100}{4} \div \frac{125}{2}$$

$$b = \frac{\overset{91}{\cancel{455}} \times \overset{1}{\cancel{\overset{25}{\cancel{100}}}}}{\underset{1}{\cancel{4}}} \times \frac{2}{\underset{1}{\cancel{\underset{5}{\cancel{125}}}}}$$

We multiply by the reciprocal of the divisor.

$$b = 182$$

Thus $113\frac{3}{4}$ is $62\frac{1}{2}$% of 182.

Try your skill at the next problem.

(b) 6% is what number of 15?

Solution

________ is ________ % of ________ .

a r b

PERCENT INCREASE, PERCENT DECREASE, PERCENT ERROR AND DISCOUNTS

Percent increase, percent decrease, percent error, and discounts are further applications of percentage problems. They have readily identifiable 'amounts', but the 'bases' are more difficult to identify.

Generally, we will find the following summary useful for identifying the 'amount' and the 'base'.

Percent Increase	Percent Decrease	Percent Error	Discount
a - actual amount of increase	a - actual amount of decrease	a - actual amount of error	a - amount to be marked off
b - original quantity before the increase	b - original quantity before the decrease	b - required or standard quantity	b - original price before the discount is subtracted
r - rate	r - rate	r - rate	r - rate

EXAMPLE 1:

Big John's Lumber Company is preparing a shipment of lumber. Part of the order calls for one 'six by six' timber which is 3.5 m long. The quality control section measures the timber and finds its length to be 3.2 m. What percent error is represented by the actual length of the timber?

Solution

Actual amount of error: 3.5 - 3.2 = 0.3 m
Required measurement: 3.5 m

0.3 m is ________ % of 3.5 m

a r b

$$\frac{0.3}{3.5} = \frac{r}{100}$$

$$3.5 \times r = 0.3 \times 100$$

$$\frac{\overset{1}{\cancel{3.5}} \times r}{\underset{1}{\cancel{3.5}}} = \frac{0.3 \times 100}{3.5}$$

$$r = \frac{30}{3.5}$$

$$r = 8.6$$

The timber had a 8.6% error from the specified 3.5 m.

EXAMPLE 2:

In the International Union of Operating Engineers, a journeyman welder received a 9.2% increase in pay on April 1, 1983. (a) If his hourly wage was $12.10 before the increase, what is the hourly increase he received? (Round the answer to the nearer cent.) (b) What was his new hourly wage?

Solution

(a) The amount of increase was not given, but the base pay is.

$$\underset{a}{\underline{\qquad\qquad}} \text{ is } \underset{r}{\underline{9.2}}\% \text{ of } \underset{b}{\underline{12.10}}$$

$$\frac{a}{12.10} = \frac{9.2}{100}$$

COMPLETE

Thus, the welder received a ______________________ per hour increase in pay.

(b) New Wage = Old Wage + Increase

= _______________ + _______________

= _______________

His new wage was _______________

EXAMPLE 3:

In Central Alberta a workman noted on December 22 (the shortest day) the sun rose at 8:45 a.m. and set at 4:15 p.m. On June 22 (the longest day) the sun rose at 5:00 a.m. and set at 10:00 p.m. What is the percent increase in the number of hours of sunlight on those dates?

Solution:

First we must find the number of hours of sunlight on each of the dates.

	Morning Hours	Afternoon Hours	TOTAL
Shortest Day	There are 3 hours 15 minutes from 8:45 a.m. to 12 noon. 3 h 15 min $= 3\frac{15}{60}$ $= 3\frac{1}{4}$ $= 3.25$ h	There are 4 hours 15 minutes from 12 noon to 4:15 p.m. 4 h 15 min $= 4\frac{15}{60}$ $= 4\frac{1}{4}$ $= 4.25$ h	3.25 + 4.25 = 7.50 h
Longest Day	There are 7 hours from 5 a.m. to 12 noon.	There are 10 hours from 12 noon to 10 p.m.	7 + 10 = 17 h

Amount of increase: 17 - 7.50 = 9.50 h

Base (or shortest day): 7.50 h

$\underset{a}{\underline{9.50}}$ h is $\underset{r}{\underline{\qquad\qquad}}$ % of $\underset{b}{\underline{7.50}}$ h

$$\frac{9.50}{7.50} = \frac{r}{100}$$

Since the numerator is more than the denominator, r will be more than 100.

COMPLETE

Thus the increase in the number of hours of sunlight was ________________%
(to the nearer percent).

EXAMPLE 4:

Tony purchased a bandsaw on sale for \$884. If the original price was \$1040, what percent discount did he receive?

Solution

Amount of discount: \$1040 - \$884 = \$156
Base or original price: \$1040

$\underbrace{\$156}_{a}$ is $\underbrace{\qquad\qquad}_{r}$ % of $\underbrace{\$1040}_{b}$

$$\frac{156}{1040} = \frac{r}{100}$$

COMPLETE

Tony received a ______________________ % discount.

INTEREST

A knowledge of percents is also necessary when we must calculate interest.

INTEREST is a fee paid for the use of money loaned or borrowed.

Interest is usually calculated on a percentage basis. In calculating interest, you will use a special interest formula rather than the proportion $\frac{a}{b} = \frac{r}{100}$ you used in other percentage problems.

INTEREST FORMULA

$$\underline{i = p \times r \times t}$$

where i is the interest;
p is the principal (ie, the amount borrowed or the amount deposited);
r is the rate (in ratio or decimal form);
and t is the time for which the money is borrowed or deposited. (This must correspond to the time period quoted in the rate).

EXAMPLE 1:

William Smithers borrowed \$8 000 from the bank at a rate of $12\frac{1}{4}\%$ per year.

After two years, Mr. Smithers returned to the bank to pay off the entire loan plus the interest. How much did he pay?

Solution:

PERCENT DECIMAL FORM

$i = \underline{\qquad\qquad}$, $p = \$8\,000$, $r = 12\frac{1}{4}\% = 12.25\% = 0.1225$, $t = 2$ yrs.

(We are calculating the interest) (the amount borrowed)

(Since the rate is expressed as a yearly rate, the time must be given in years.)

$i = p \times r \times t$
$i = 8\,000 \times 0.1225 \times 2$
$i = \$1960$

Thus, he will pay $1960 in interest.

We must now calculate the total amount he paid the bank (ie, principal plus interest).

Total Amount = Principal + Interest

= ____________________ + ____________________

= ____

Mr. Smithers paid the bank ________________ in repayment of his $8000 loan.

EXAMPLE 2:

What is the interest paid on a $1500 loan, if the interest rate is 9% per year and the term of the loan is 30 months?

Solution

$i = \underline{\qquad\qquad}$, $p = \$1500$, $r = 9\%$, $t = 30$ mo. $= \frac{5}{2}$ yr.

$i = p \times r \times t$
$i = 1500 \times 0.09 \times \frac{5}{2}$

$i = \$337.50$

(Since the rate is a yearly rate, the time must be expressed in years.
[30 MO. $= \frac{30}{12}$ YR. $= \frac{5}{2}$ YR.])

Thus, $337.50 in interest must be paid on the loan.

EXAMPLE 3:

Charlie Jones made a $110 payment on his building supply bill of $432. He must pay $1\frac{1}{2}\%$ per month on the unpaid balance. How much interest will be due on Charlie's next bill?

Solution

$i = \underline{\qquad}$, p (unpaid balance) = $432 - ___ = ___, $r = 1\frac{1}{2}\% = 1.5\% = 0.015$,

t = 1 month (SINCE THE RATE IS "PER MONTH", THE TIME MUST BE EXPRESSED IN MONTHS.)

$i = p \times r \times t$
$i =$ ________ $\times\ 0.015 \times 1$
$i =$ ________

On next month's bill, Charlie will have ______________________________ interest due.

SELF CORRECTING EXERCISE 6

1. For each of the following, put the problem into the general form 'a is r% of b'. (Leave a blank for the unknown quantity.)

   (a) What is 5% of 93?

   ______ is 5% of 93.

   (b) 71% of what number is 152?

   (c) 34 is what percent of 19?

   (d) 23% of 68 is what number?

   (e) 87% of what number is 929?

2. Using each of the following problems expressed in the general sentence form 'a is r% of b', set up the ratio $\frac{a}{b} = \frac{r}{100}$.

   (a) 63 is r% of 29.

   $$\frac{63}{29} = \frac{r}{100}$$

   (b) a is 17% of 138.

   (c) 44 is 32% of b.

(d) a is 296% of 137.

(e) 51 is r% of 17.

Complete the following exercises and send them in for correction.

EXERCISE 1

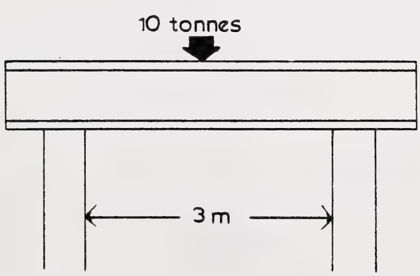
1. George can carry three times as many boxes as Ken. If Ken carries 98 boxes in one hour, how many boxes can George carry?

2. If three machines turn out 1500 pieces of work per day, how many machines would be needed to turn out 2500 pieces per day?

3. If 5 labourers each earn \$492 per week, how many labourers could be hired for \$3400 per week?

4. The cost of 3 bolts is 81 cents. Calculate the cost of 4 dozen of the same kind of bolts.

5. The safe load that a beam can carry is inversely proportional to the distance between the supports. If a certain beam can carry a load of 10 tonnes when the supports are 3 m apart, what safe load will this beam carry when the supports are placed 20 m apart?



EXERCISE 2

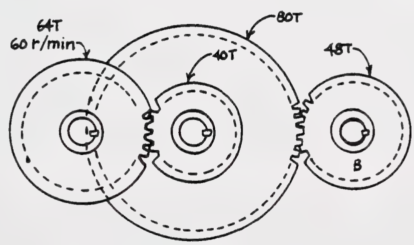
1. A power shaft rotating at 200 r/min is fitted with a gear of 36 teeth. What size of gear should be placed on the follower shaft to give a speed of 300 r/min?

2. A gear with 120 teeth is rotating counter-clockwise with a speed of 74 r/min. This gear drives a follower gear with 84 teeth. What speed will the follower gear rotate at?

3. A line shaft pulley of 8 cm diameter is rotating at 4200 r/min. If the pulley is to be belted to another pulley which must run at 1000 r/min, what size pulley should be used?

4. A pulley 10 cm in diameter is rotating 360 r/min and is cross-belted to a pulley 12 cm in diameter. Find the speed of the 12 cm pulley.

5. In the compound gear train below, at what speed does the 48 toothed gear rotate at?



EXERCISE 3

1. A car which costs $5 375 depreciates 25% during the first year. (a) How much is lost to depreciation during the first year? (b) What is the value of the car after the first year?

2. The selling price of a house and lot have increased by 450% over a period of 20 years. (a) By what amount has the price increased, if the original price of the house and lot was $12 500? (b) What is the present value of this property?

3. A plank has a measurement which is 0.5 dm in error. (a) If this represents a 3% error, what should be the length of the board to the nearer tenth of a dm. (b) If the plank is shorter than it should be, how long is it?

4. A circuit loses 5 volts in the wiring resistance. This loss is 3.5% of the line voltage. What is the line voltage to the nearer volt?

5. An overnight camping trip was being planned for a troop of Boy Scouts. 15 two-man tents were being purchased for the outing. Each tent cost $149.98 and the troop was given an 18% discount on the purchase.
   (a) What was the total cost of the 15 tents before the discount?
   (b) What was the amount of the discount taken off the total price?
   (c) What was the total amount paid by the Boy Scout troop?

EXERCISE 4

1. Jack borrowed $1 600 from the bank at a rate of 14% per year for 3 months. How much interest will he owe at the end of the 3 months?

2. Robert Blackford invested $13 000 in a term certificate at 9.5% per year. The term of the certificate was 3 years. How much money will Robert have at the end of the three years?

3. On his vacation, George used a credit card to make several purchases. He charged a total of $835. When the bill came due, he was only able to make a payment of $35. If interest is charged at a rate of 1.5% per month on the unpaid balance, how much interest will he have to pay next month?

4. To help buy a new car, Ralph borrowed $3 000 from his Uncle Paul. At the end of 18 months, how much money did Ralph owe Paul? (The agreed rate of interest was 8.8% per year.)

Answers to Self-Correcting Exercises

S.C.E.- #1

1. any example using the format $\frac{a}{b}$ such as $\frac{2}{3}$.

2. any example using the format $\frac{a}{b} = \frac{c}{d}$ in which the fractions are equal i.e. $\frac{2}{3} = \frac{4}{6}$

3. both ratios are equivalent.

4. any example in which the ratios are not equivalent i.e. $\frac{2}{4} = \frac{5}{8}$

5. the ratios are not equivalent.

S.C.E. - #2
1. 347 r/min
2. 1400 r/min
3. 25.5 cm
4. 1246 r/min

S.C.E. - #3
1. 47%
2. 62/100
3. 14/100
4. 106%
5. 875/100
6. 27%

S.C.E. - #4
1. 528%
2. 6830%
3. 35900%
4. 7%
5. 4237%
6. 38%

S.C.E. - #5
1. 1.93
2. 0.06
3. 0.168
4. 0.63
5. 0.94
6. 0.0832

S.C.E. - #6
1. (b) 152 is 71% of ____________________

   (c) 34 is ____________________% of 19.

   (d) ____________________ is 23% of 68.

   (e) 929 is 87% of ____________________.

2. (b) $\frac{a}{138} = \frac{17}{100}$

   (c) $\frac{44}{b} = \frac{32}{100}$

   (d) $\frac{a}{137} = \frac{296}{100}$

   (e) $\frac{51}{17} = \frac{r}{100}$

END OF LESSON 18

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________________

Time Spent on Lesson ____________________

(If label is missing or incorrect)

File Number ____________________

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ______

Date Lesson Received: ____________________

Lesson Recorded ______

Student's Questions and Comments

Apply Lesson Label Here

Name ____________

Address ____________

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____

Postal Code ____________

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

POWER TOOLS AND MACHINES

Power machines
Portable power tools

INTRODUCTION

Although most woodworking jobs can be done accurately with hand tools, there is a definite need for power tools. Power tools cut faster and easier than hand tools. Power tools also can be set up to repeat the same job with the same accuracy time and again thus speeding up an operation.

There is, however, a danger in believing that power tools are the answer to every problem. Power tools, if incorrectly used, can turn a small problem into a large one quickly because of their faster cutting speeds. A good example of this is in the comparison of hand sanding to sanding with a belt sander. If the belt sander is properly used it is much faster than hand sanding. However, if the belt sander is held in one spot or tipped so the edge of the belt cuts into the wood a groove up to 3 mm deep could be made in seconds. This would ruin most projects. With hand sanding this could never happen.

Another consideration to take into account is safety. If you accidentally slip while using hand cutting tools, the resulting cut will be fairly minor. A person who accidently cuts himself with a power saw usually loses fingers and sometimes his entire hand. This is a large price for one minor mistake.

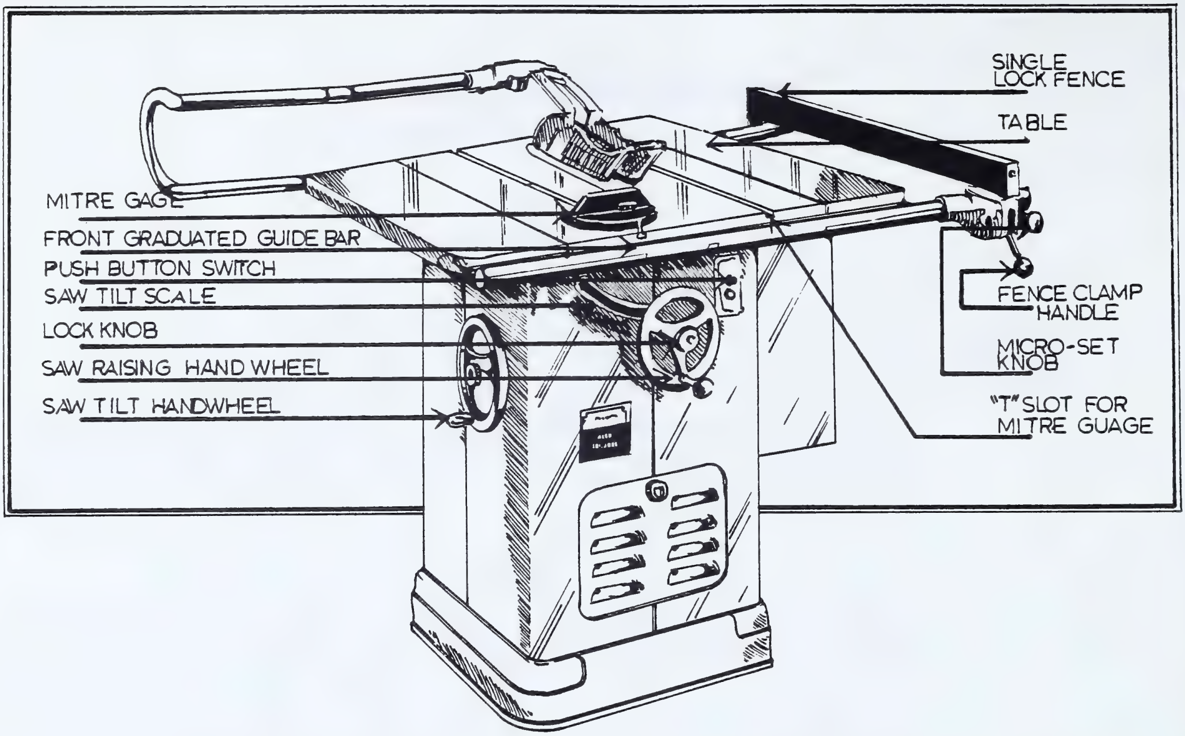
It is very difficult to explain how to safely use power tools without the aid of an actual demonstration. For that reason, this lesson will not attempt to explain how to operate the tools and machines. The lesson will introduce the tools and explain the types of jobs they are used for.

POWER MACHINES

1. Bench Saw (table saw)

The most common style of table saw is the tilting arbor table saw. In this style the blade is tilted sideways up to 45° by moving the entire motor and drive mechanism. This type of saw is considered more accurate and easier to operate than the titling table style of table saw.

The table saw is used for a wide variety of jobs. These include the basic cuts of crosscutting, bevel crosscutting, mitres, bevel mitres, ripping, and bevel ripping. Other jobs such as dadoes, rabbets, and molding can also be done.



The size of a table saw is determined by the diameter of the largest blade which will fit on the saw. The 200 mm, 250 mm, and 300 mm sizes are most common. The 200 mm size is often used by the home handyman. The 250 mm to 300 mm size is more commonly used by the contractor or cabinet maker.

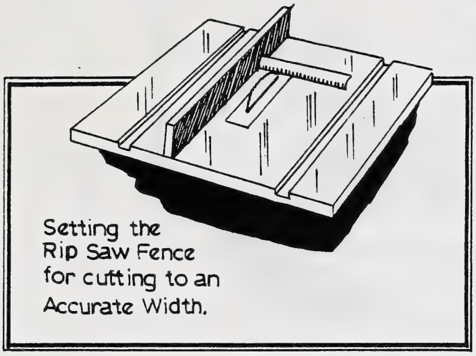
A variety of blades are available for a table saw. There are rippng blades, cross cutting blades, and combination blades in use. Most home handymen use a combination blade as it will safely perform both crosscut and rip type operations. All of these blades are available as standard blades or carbide tipped. The standard blades are less expensive to buy than the carbide tipped blades but they do not stay sharp nearly as long.

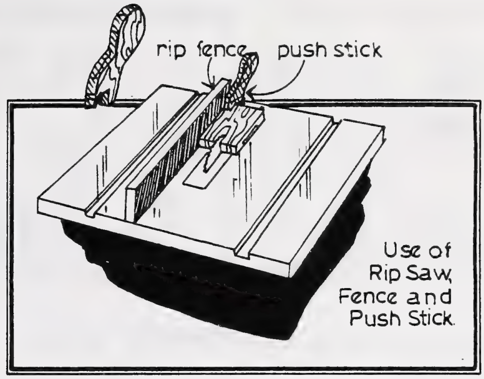
The procedures listed below are for cutting lumber. There are some changes made when cutting plywood.

(a) Ripping on the table saw.

Below is a list of the procedures and checks which are followed when ripping lumber on a table saw. Remember this procedure is never used when cutting across the grain in lumber.

(i) The rip fence is used for all ripping operations. Do not rip freehand. Adjust the rip fence the the proper distance from the saw blade to give you the correct width of board. Your good piece of work should always, whenever possible, go between the saw blade and the fence. This keeps the width of your cut board constant.





(ii) Adjust the blade height so it will be 3 mm above the thickest part of the board. Do not leave the blade higher as it may lead to a more serious cut if you happen to slip.

(iii) Make sure you have a blade which is suitable for ripping lumber.

(iv) Always use the safety guard. It will not only help protect you from accidentally slipping into the saw blade, but it will also keep the board from kicking back towards you if it binds and is grabbed by the saw blade.

(v) Push the work into the saw by applying feed pressure between the saw blade and the fence.

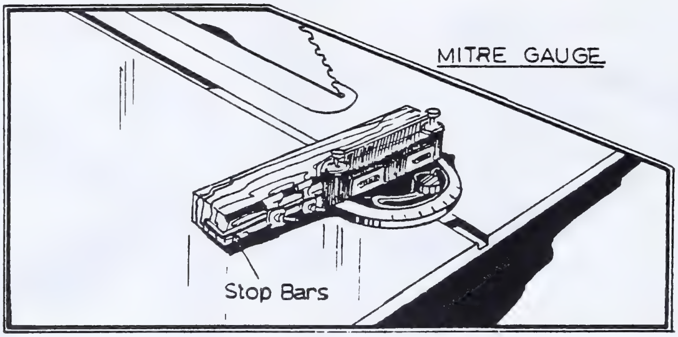
(vi) Use a push stick when cutting narrow stock (work 100 mm wide or less). Push on the part of the work which is betwen the saw blade and the fence. Leave the other part of the work free.

(vii) When operating the saw, stand to the left of the saw blade so you will not be hit by the board if it kicks back. Kick backs can be violent and cause serious injury. The board going between the saw blade and the fence is the one which will kick back.

(b) Crosscutting on the table saw.

The following information includes a list of procedures which should be followed when doing crosscuts on a table saw.

(i) The mitre gauge is used for all crosscut operations. Never cut freehand and never try to crosscut using the rip fence as the work will bind between the side of the saw blade and the fence and be thrown back at you.



(ii) Use a crosscut saw blade or a combination blade.

(iii) Adjust the blade height so it is 3 mm above the thickest part of the work for normal crosscutting and to the necessary height when cutting dado and rabbet grooves.

(iv) Always use the safety guard.

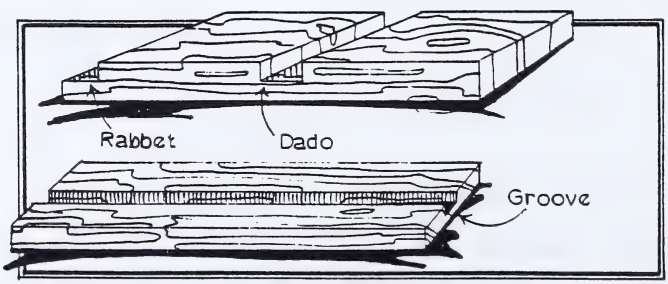
(v) Hold onto the part of the work which is guided by the mitre gauge. Leave the other end free so that it will not bind and kick back towards you.

(c) Special operations

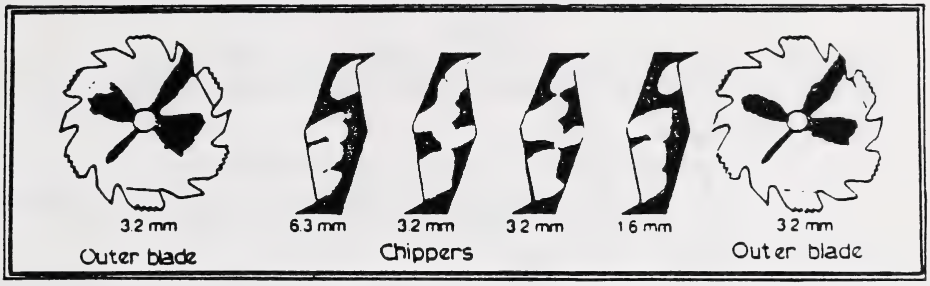
The table saw may be used for many special operations. Some of these are listed below.

(i) Dadoing, grooving, rabbeting

Dadoing means cutting a wide slot across the board in the centre portion (not at the ends). Grooving means cutting a wide slot down the length of the board. Rabbeting means cutting a wide slot in the end or edge of a board.



These cuts are done with a dado head.

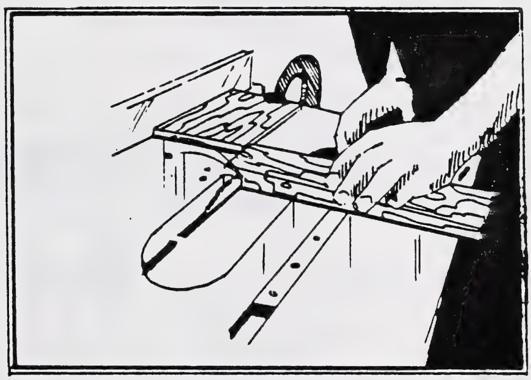


The dado head is set up using the two outer blades and as many chippers as necessary to get the correct width of cut.

When cutting a dado or rabbet across the board use the same setup as for crosscutting. For doing a groove or a rabbet down the length of the board use the same setup as the ripping.

(ii) Cutting duplicate lengths

A special set up is used for cutting duplicate lengths. It is shown below.This involves having a stop block clamped only at the front of the table. This will be used to position the work the same way for each cut.



Notice that the work clears the stop block before the cut is started. This insures that there will not be a kickboard.

(d) Safety

(i) Use the correct type of blade for the operation being done.

(ii) Set the blades to the correct height.

(iii) Use the rip fence for ripping and the mitre gauge for crosscutting. Do not cut freehand.

(iv) Use a push stick when ripping narrow stock.

(v) Keep one piece of the board free.

(vi) Do not push material into the saw with your hand placed directly in front of the blade.

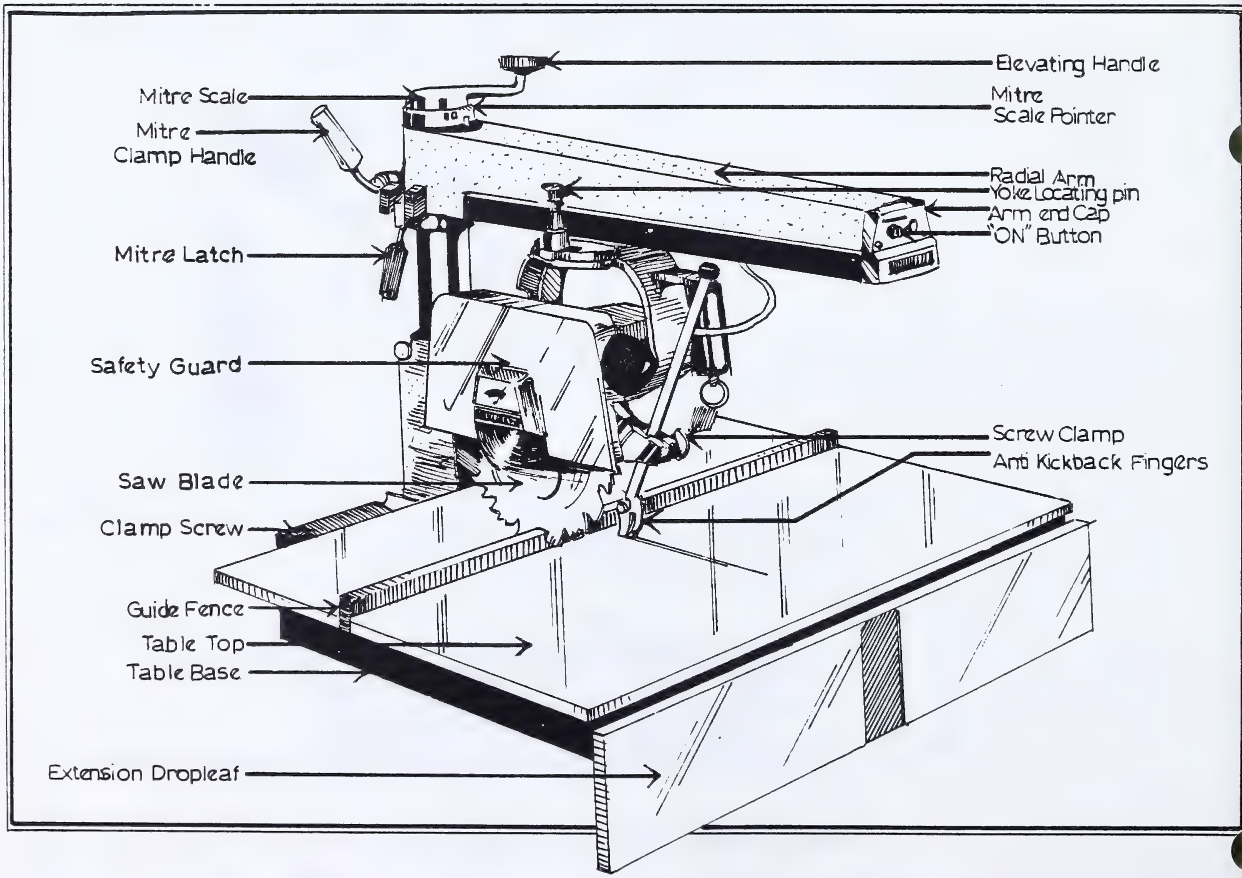
(vii) Always use the safety guard.

2. Radial Arm Saw (radial saw)

The radial arm saw is used for the same types of operations that the table saw is used for. It can do crosscutting, ripping, dadoing, etc.

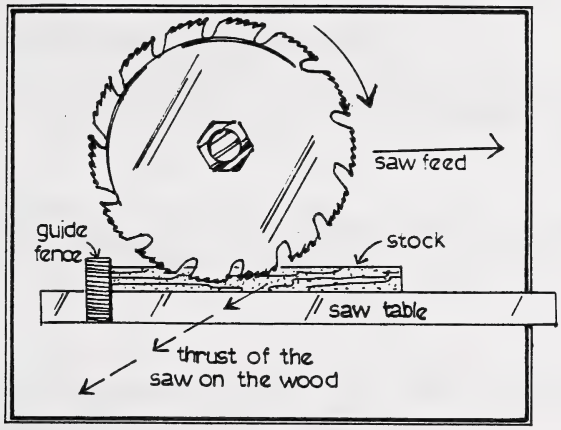
The radial arm saw is more convenient for crosscutting operations and the table saw is more convenient for ripping operations although each saw can do both operations.

Radial arm saws come in a variety of sizes. These sizes are based on the maximum blade sizes (as on table saws). The most common sizes are 300 mm or 350 mm.



(a) Crosscutting on the radial arm saw

Crosscutting boards, especially longer ones, is easier to do on the radial arm saw since the board remains stationary against the fence and it is the saw which is moved.



Below is a list of procedures and checks which are followed when crosscutting on a radial arm saw.

(i) Make sure there is a crosscut or a combination blade on the saw.

(ii) Adjust the blade for the correct depth. When the board is to be cut off, the blade should be adjusted so that it will cut one to two millimetres into the saw's table top. This is to ensure that the saw cuts completely through the boards. Of course, if you are cutting a dado, you would adjust the blade for the required depth of cut.

(iii) The guard should always be used. It should be in a horizontal position. The anti-kickback fingers of the guard should be two to three mm above the work so they act as as an extension of the guard.

(iv) The work should be held firmly against the table and fence by one hand only. The other end of the work should be free or it may kick back.

(v) If you are holding the material to the left of the saw blade, your left hand must hold the material and your right hand runs the saw. However if you are holding the work to the right of the blade, your left hand must operate the saw. DO NOT CROSS YOUR HANDS. This puts you in an extremely dangerous position where your hand is in front of the path of the saw.

(vi) Never at any time place a hand in the path of the saw while it is running as it could possibly kick forward into your hand.

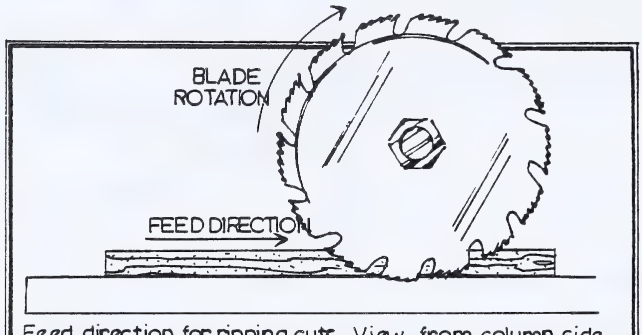
(vii) Draw the saw slowly forward until it cuts through the board and then push the saw rearward to the back of the table. Do not move the board until the saw is in the rear position.

(viii) Hold the saw firmly as the blade will tend to push the motor unit towards the operator causing the saw to jam and stall.

(b) Ripping on the radial arm saw

The setup for ripping on the radial arm saw is more time consuming and difficult than on the table saw. The actual ripping operation is also more difficult to do on the radial arm saw as the motor and blade is above the work and it could be in the way.

When ripping on the radial arm saw, the saw remains stationary and the board is fed into the saw along the fence.



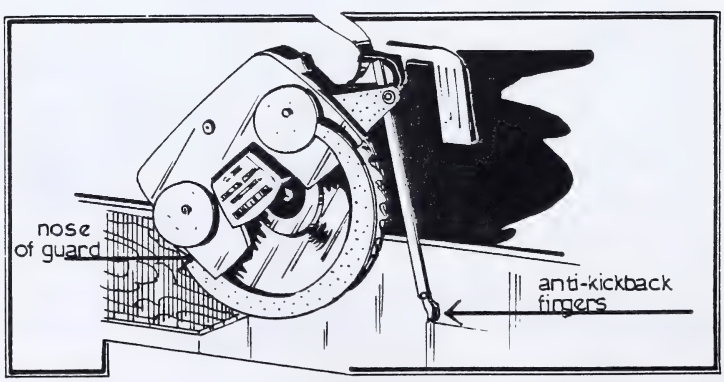
Feed direction for ripping cuts. View from column side.

Below is a list of procedures and checks which are followed when ripping on a radial arm saw.

(i) Make sure there is a rip blade or a combination blade on the saw.

(ii) Adjust the blade for the correct depth of cut. The adjustment is made the same as for crosscutting.

(iii) The guard should always be used. It is positioned so the nose of the guard clears the work by 3 mm.



The anti-kickback fingers are adjusted so they will grab the work to prevent a kick back of the wood.

(iv) Slowly feed the material under the nose of the guard and into the saw.

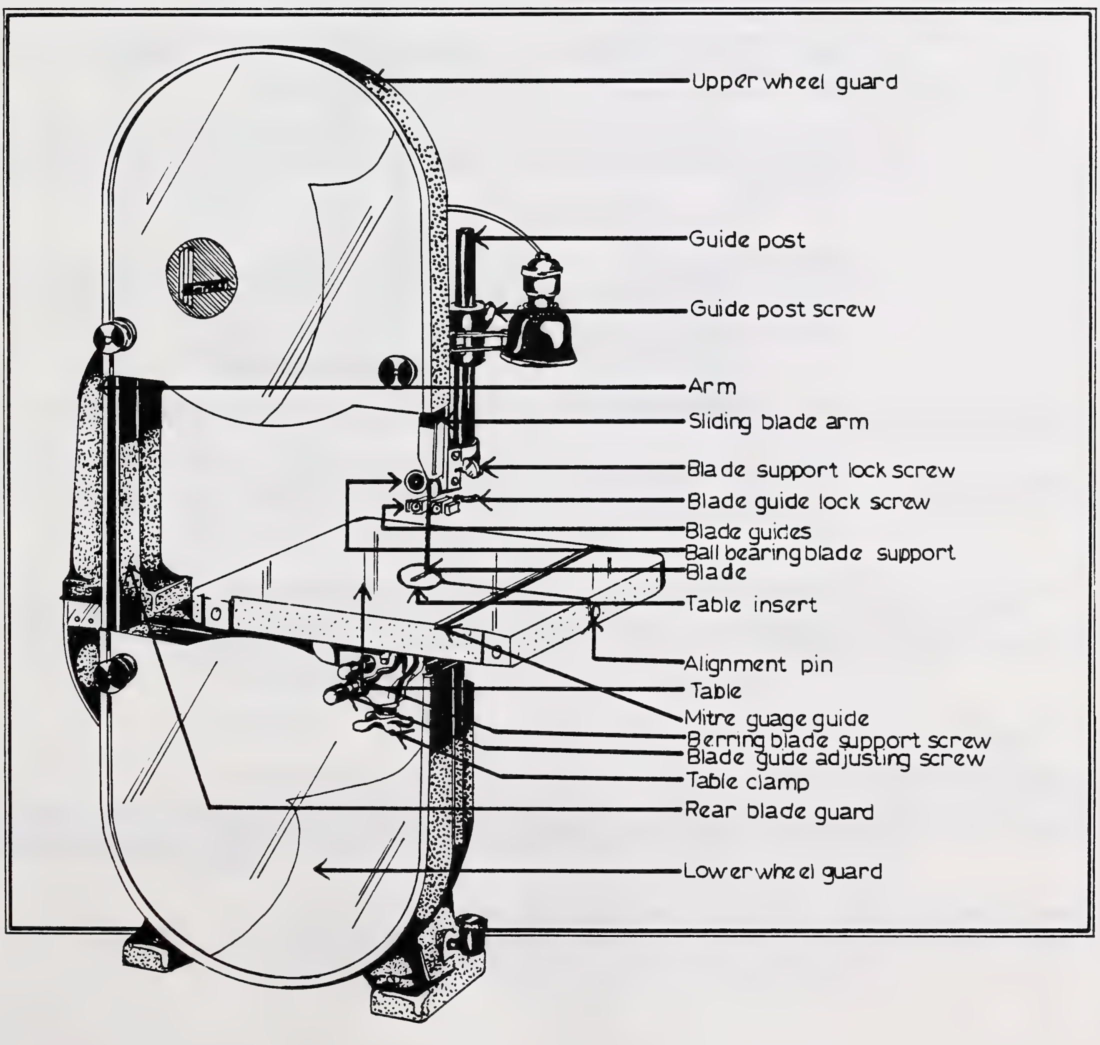
(v) Never feed work into the anti-kickback finger end of the saw. The blade will grab it and violently pull it out of your hands.

(vi) Use a push stick for feeding narrow work.

(vii) Feed the stock by pushing on the piece of material which goes between the saw blade and the fence. The other end of material should remain free.

3. Band Saw

The band saw as its name implies has a saw blade in the form of a long continuous band with teeth on one edge. This band runs on two large rubber tired wheels.



The size of a band saw is determined by the diameter of the wheels. The 350 mm, 500 mm, and 750 mm diameters are popular sizes for general work.

Band saws are used for both cross cutting and ripping. Since the band saw blade is always moving straight downward as it cuts, there is no danger of a kickback. The work can be fed into the band saw freehand (guided by your hands) or with a rip fence or mitre gauge.

These saws are used primarily to cut curves, circles, and designs. The fact that the depth of the blade from the tooth edge to the back is very short means that the blade will cut small diameter curves. Blades will cut to the side if they can twist in the kerf and then cut slightly to the side. A small blade will twist more in the kerf enabling the blade to angle a greater amount to the side. Band saws can also do straight line cuts. However the band saw does not make cuts which are as straight as the table saw or the radial arm saw. Where possible, straight crosscuts and rip cuts are done on the table saw and radial arm saw. The angle or curve cuts are done on the band saw. The band saw works well cutting on irregular shaped material as well.

Below is a list of important points concerning the operation of the band saw.

(a) When feeding material into the saw never position a hand directly in front of the blade as any slip will mean your hand will hit the blade and a very serious cut will result.

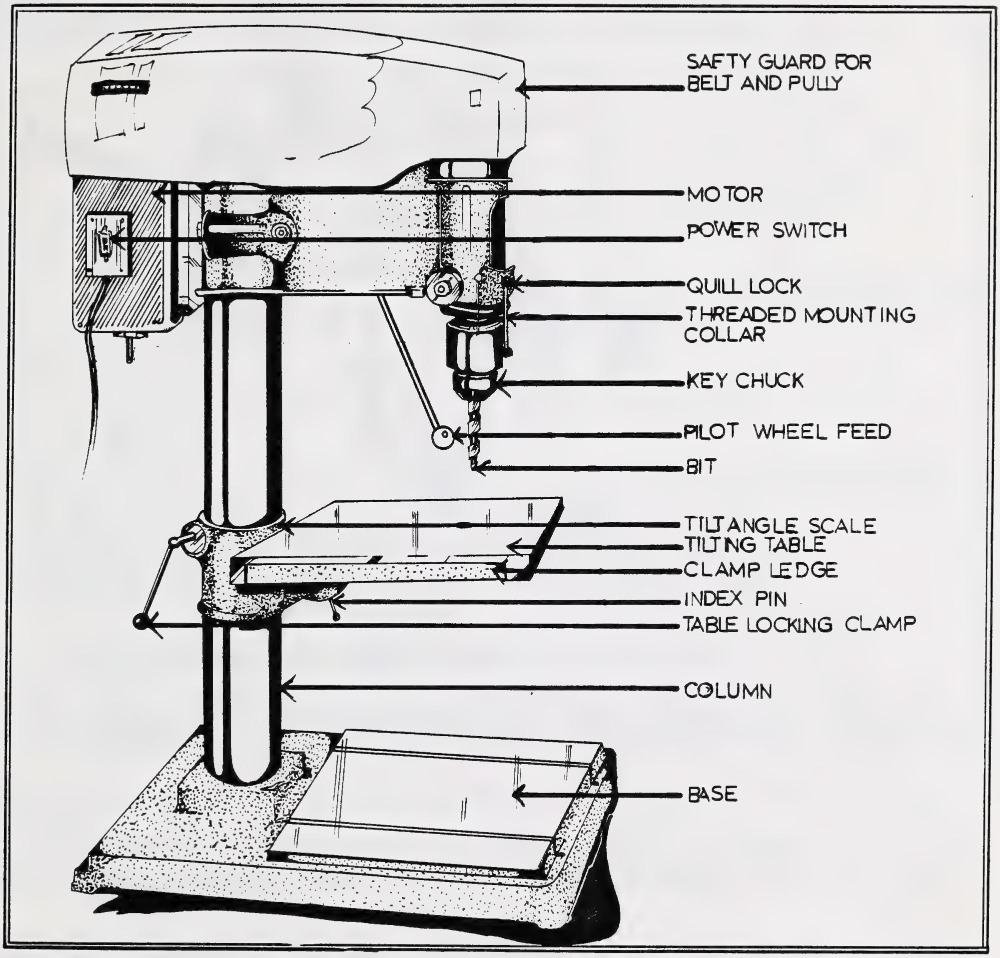
(b) When backing out of a cut it is possible to pull the blade off the wheels and cause it to jam. This backing out can be done in two ways.Remember the first one is the best way.

    (i) Shut the saw off and wait for the saw blade to stop before backing out the cut.
    (ii) Very slowly and carefully back out with the saw running. Reverse all the moves you made when cutting and watch the blade to ensure it is not being pulled forward.

(c) Remember that the upper guide unit not only supports the band saw blade but forms part of the guard. Adjust it so that it is 3 mm above the thickest part of the work.

4. Drill Press

The drill press is a machine used to replace the hand drill and brace for making holes in wood, metal, or other materials. The drill press ensures that holes are made square to the material.



The drill press can decrease the time and effort that would be required to make holes compared to hand or breast drill. The drill press can also make larger holes than is possible with the hand or breast drill.

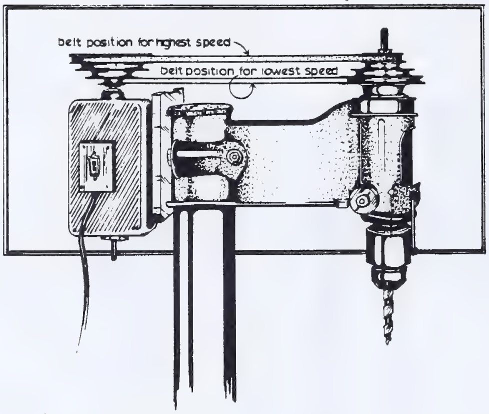
Drill presses are adjustable for the speed that they turn the bit. This is necessary because of the variety of different diameters of bits used in it. Drill speed is the distance the drill would travel in one minute if it were rolled on its side. A small drill must be rotated faster than a large one to cut at the same drilling speed.

EXAMPLE:

When using a high speed twist drill to make a hole in mild steel, the drill speed should be 30.5 metres per minute. This means a 3.2 mm drill should turn at 3057 r/min to get this drill speed. A 25.4 mm drill should turn at 382 r/min to attain this same drill speed.

Drill speed is different for different types of bits or drills and for different materials as well. The instruction or owner's booklet for each drill press should give the required drill speeds. Textbooks are another source for finding drill speeds.

A drill press is adjustable for speed through the use of a step pulley on the motor and another pulley on the drill press spindle shaft (which attaches to the chuck).



The drill press allows the operator to feed the drill more evenly and steadily than a hand drill. Feed is the distance the drill moves into the stock with each turn. This is a tremendous help as it means fewer broken or chipped drill bits and smoother holes in the material.

Below is a list of procedures to follow when using a drill press

(a) Select the correct bit. Drill presses use only round and hexagonal shanked bits. Do not attempt to use square tanged bits in a drill press chuck.

(b) Ensure that the speed is set correctly for the type and size of bit used.

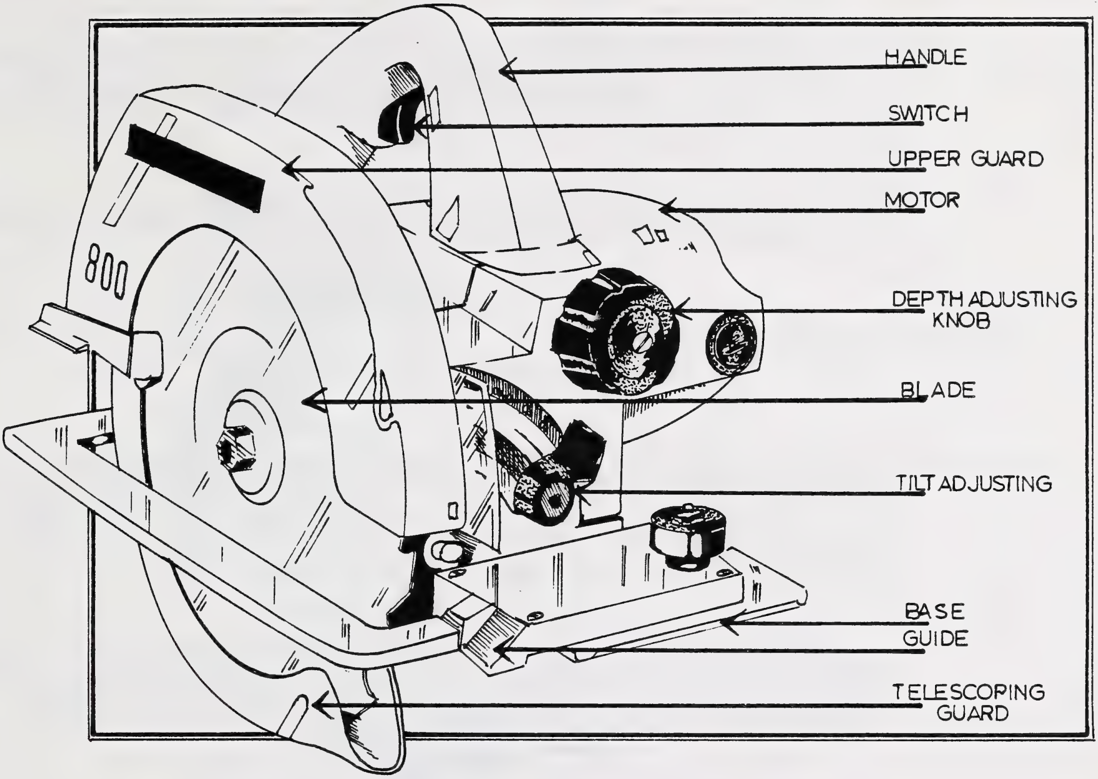
(c) Set the depth stop if the hole is not to be drilled all the way through the material. The depth stop will only allow the drill to move downward to the depth it was set at.

(d) Use a vise or clamp to properly secure smaller material. A hand can easily be cut if the drill grabs small material such as a piece of sheet metal and rotates it through your fingers.

(e) Align the drill with the hole in the table when drilling in metal. When boring a hole in wood place a scrap piece of plywood on top of the table and set the depth stop so you will go through your material and only slightly into the scrap. Drill bits would be ruined if they touched the metal table and the good piece of wood would be chipped if it were not supported from below. The same procedures to avoid chipping as used for a brace are used on a drill press.

5. Portable Circular Saw

The portable circular saw is used by carpenters for framing and other rough construction. It is not used for fine work such as cabinet making. This job is done using the table saw and perhaps the radial arm saw.



The size of the portable circular saw is determined by the largest diameter blade which will fit into it. Sizes vary from 12 cm to 25 cm. The 18 cm size is the most common.

The depth of cut is made variable by raising or lowering the motor on the base. The depth of the saw is adjusted so that it is equal to the thickness of the work plus 3 mm.

Most portable circular saws can be adjusted to make a level cut by tilting the base. Angles of up to 45° are possible.

Portable circular saws are usually guided freehand along a line. To help prevent binding the blades are set more than those on a table saw. As you know extra set produces a rougher cut.

Below is a list of procedures to follow when using a portable circular saw.

(a) The direction of rotation of the blade is such that the portion of the blade doing the cutting is travelling forward. If the saw binds, it will kick back towards you. To avoid injury never cut with the saw directly in front of you. Position yourself to the right or left of the cutting line.

(b) Always unplug the saw when changing blades or making adjustments. The trigger is easily squeezed by accident and if done at the wrong time it could cause a serious accident.

(c) Support the stock in such a way that the kerf will not close and bind the blade. As with the table saw and radial arm saw, one end of the material should be free. The free end could be supported by a saw horse or a hand, but it should not be allowed to twist.

(d) Before turning on the switch the base of the saw should be placed on the material with the saw blade clear of the material.

6. Portable Electric Drills

Portable electric drills have largely replaced the hand drill and breast drill. The reason is they are much easier to use than the hand cranked hand drill and breast drill. The portable drill will not do any work that could not be done by the hand operated drills (except perhaps where clearances would not permit a hand cranked drill but would allow the portable electric drill).

Portable electric drills will never replace a drill press for quality of holes or ease of making them in small work. The portable drill will, however, allow for much more portability. A drill press cannot be moved easily and large work cannot be easily manouvered onto a drill press.

Portable drills are manufactured in several sizes. The 6 mm, 9 mm, and 12 mm sizes are the most common. The size is determined by the maximum diameter of drill shank that can be fitted into the chuck.

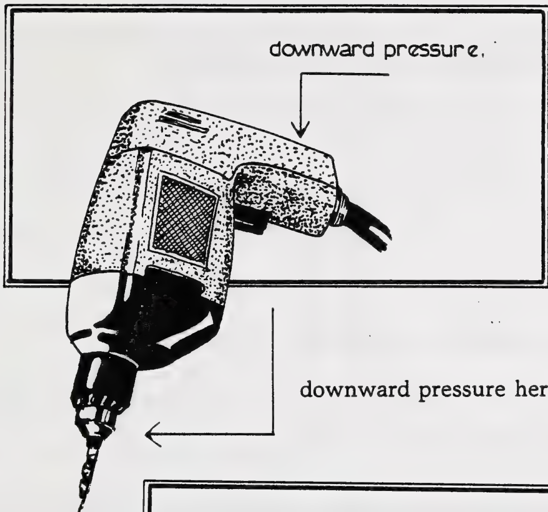
In the section of this lesson dealing with the drill press, drill speeds were discussed. At that time it was noted that small drills should be turned at high speeds and large drills turned at slower speeds. This idea is applied to the design of portable drills. The 6 mm electric drill rotates at a high speed, the 9 mm at a slower speed and the 12 mm drill at a very slow speed. For this reason it is best to use a 6 mm portable drill for small holes, the 9 mm drill for medium sized holes, and the 12 mm drill for the larger holes.

The following procedures are important to remember when using a portable electric drill.

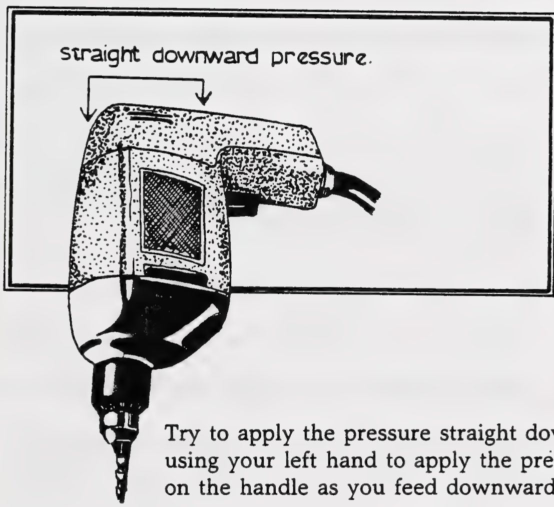
(a) Make sure to unplug the drill before installing or removing a bit from the chuck.

(b) Before starting to drill a hole in metal, the spot where the drill is to be started should be centre punched so the drill does not wander.

(c) Apply pressure straight down onto the bit. This could involve some twisting of the handle when using a small drill with the handle on the side.



downward pressure here results in side force on the bit here.



Try to apply the pressure straight downward. This can be done by using your left hand to apply the pressure or by twisting slightly on the handle as you feed downward.

(d) Small drills do not require nearly as much feed pressure as large drills. Do not let a dull drill fool you into applying too much pressure as this can easily break a drill bit.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. Even though hand tools can do a better job than power tools in most cases power tools are still in common use. Why? Give two reasons.

   (a) ______________________________

   ____

   (b) ______________________________

   ____

2. How is the size of a portable circular saw determined?

   ____

   ____

3. What is likely to happen if the operator attempts to cut freehand on a table saw?

   ____

   ____

4. (a) What is the correct height of the table saw blade above the table when cutting a piece of stock 12 mm thick?

   ____

   ____

   (b) Why is it important to ensure that the blade is set to this height?

   ____

   ____

5. What is the purpose of the mitre gauge?

   ____

   ____

6. The operator should only hold onto one end of a piece of stock when crosscutting it on a table saw otherwise it will kick back. What happens to the wood to cause a kickback when the operator holds both ends of the work?

   ____

   ____

   ____

7. When placing a dado head on a table saw, the two outer blades and enough chippers to give the correct width are used. List the chipper sizes required to make a 19 mm groove.

____

8. When constructing cabinets a rabbet joint is sometimes used. In the diagram below draw the lines necessary to complete the drawing of the rabbet joint.

9. A construction worker has 100 studs to cut. The studs were to be accurately cut to length and have square ends. Which circular saw should be chosen?

____

Give two reasons why this saw would be best?

(a) _______________

____

(b) _______________

____

10. The anti-kick back fingers on the radial arm saw are used to help prevent kickbacks when ripping. What purposes do they serve when crosscutting?

____

____

11. There is less work involved to set up a table saw for ripping than to set up a radial arm saw for ripping. Why is this?

____

____

____

____

12. A common size of band saw is 500 mm. What is the widest piece of material that could possibly be cut in half on this size of saw? Explain how you arrived at this answer.

____

____

____

13. Why is a band saw able to make sharper curves than a handsaw?

____

____

____

14. Why should a hand never be positioned in front of the blade of any saw as it feeds material into the saw?

____

____

15. For most straight line cuts a table saw or a radial arm saw is used. Why is a band saw not generally used for cutting straight lines?

____

____

____

16. Give three reasons why the drill press is better for making holes than a portable electric drill.

(a) _______________

____

(b) _______________

____

(c) _______________

____

17. Why is a scrap piece of plywood placed on the drill press table before making holes in wood?

____

____

EXERCISE 2

1. Persons operating portable electric drills tend to break drills more often than people operating drill presses. Give two reasons why this happens.

   (a) ____________________

   ____

   (b) ____________________

   ____

2. Why do you centre punch a piece of metal before you commence to drill a hole in it?

   ____

   ____

3. Give two reasons why a person would use a hand saw instead of a portable power saw.

   (a) ____________________

   ____

   (b) ____________________

   ____

END OF LESSON 19

LESSON RECORD FORM

1836 Building Construction 12
Revised 88/04

FOR STUDENT USE ONLY

Date Lesson Submitted ____________________

Time Spent on Lesson ____________________

(If label is missing or incorrect)

File Number ____________________

Lesson Number __________

FOR SCHOOL USE ONLY

Assigned Teacher: __________

Lesson Grading: __________

Additional Grading E/R/P Code: __________

Mark: __________

Graded by: __________

Assignment Code: __________

Date Lesson Received: __________

Lesson Recorded __________

Student's Questions and Comments

Apply Lesson Label Here

Name ____________________

Address ____________________

Postal Code ____________________

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____
Correspondence Teacher

St. Serv. 1-86

ALBERTA CORRESPONDENCE SCHOOL

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do **not** enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a **green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.**

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

OCCUPATIONAL OPPORTUNITIES IN BUILDING CONSTRUCTION

Carpentry apprenticeship
Other apprenticeship trades
Other job opportunities

INTRODUCTION

The careers that are open to a person with a carpentry background are many and varied. The opportunities are directly proportional to the effort put out in acquiring a good basic education, especially in mathematics, english, social studies and science, plus the knowledge you acquire in the carpentry trade itself. There are many specialities within the trade and a wide variety of occupations closely related to carpentry. Some of the related fields in which knowledge of basic tools and techniques of carpentry would be valuable are dry-walling, roofing, concrete contracting, mobile home and trailer manufacturing, painting, decorating, etc.

Carpentry is a very satisfactory occupation. Both yourself and others can stand back and see what you have done. You can have pride in a well-constructed finished project, whether small or large.

Carpentry can also give you a more than adequate livelihood. Many carpenters are earning relatively high incomes. Many young men and women are finding the wages and the variety of work in carpentry very satisfactory. There is usually no shortage of work, especially for a carpenter who takes his trade seriously, learns with enthusiasm when opportunity arises, and does high quality work.

CARPENTRY APPRENTICESHIP

1. Training

A journeyman carpenter, to be certified as such, must take instruction in all phases of the carpentry trade. This means that you do not become, specifically, a heavy construction carpenter, or a finishing carpenter, or a framing carpenter, etc. However, after attaining their journeyman carpenter certificate, many carpenters do specialize in specific work within the field of carpentry. It is to your advantage not to specialize too early in your training. By having a broad basic education and training in carpentry, you have a wider choice of jobs within the trade and can switch more easily to other jobs in carpentry when a shortage of work develops in any other job.

There are two routes which can be taken to become a journeyman carpenter.

(a) The carpentry apprenticeship program in Alberta is normally over a four year period. In each of the four years you will spend two months at one of the Technical Institutes learning carpentry theory, shopwork, mathematics, drafting, and shop drawing. Each year builds on your education from the previous year and it will be an enjoyable part of your apprenticeship.

At the end of the four years if you have satisfactory evaluations from your employer, the technical institute you attend, and the Provincial Apprenticeship Board, you will obtain a Journeyman Carpenter Certificate.

(b) There is another route to qualification. If you attend a Composite High School and satisfactorily complete the Building Construction 12, 22, and 32 program, you will 'receive twelve months time credit and can take first and second year apprentice examinations'. At the end of three years of satisfactory employment and evaluations from the Apprenticeship Board, you will receive certification as a carpenter.

2. General Information

(a) The following is copied from 'Apprenticeship Training Carpenter Program' published by Alberta Advanced Education.

APPRENTICESHIP INFORMATION

Basic Qualifications

- Indenture for four periods of experience and training (normally four years).

- Attend technical training courses for eight weeks in each period.

- Fulfill all the requirements for each period including a minimum number of hours of work experience, successfully complete the training course and obtain a satisfactory employer's report.

- Education - a minimum acceptable education is a Grade 9 pass or equivalent as established by the Apprenticeshihp and Trade Certification Branch.

- Age - the minimum age for apprentices is 16 years. There is no upper age limit.

Credits

Accelerated patterns of apprenticeship may be granted for related technical trade and/or experience.

Benefits

* Apprenticeship is a learning-while earning program. During the apprenticeship period, while working at the trade, apprentices are assured by regulation of a minimum percentage of the prevailing journeyman rate: 60% first period, 70% second period, 80% third period, 90% fourth period. Progress from one rate to another takes place only upon successful completion of all the requirements of the period.

* Subsistence allowances are paid while attending classes (see the General Brochure for current rates and qualifications.)

* The school courses are provided without fee through the Apprenticeship and Trade Certification Branch and are paid for by the Provincial and Federal Governments.

* Transportation - one return fare, for each school course is paid to the apprentice who lives outside the community or city where he will be attending school.

* An apprentice who successfully completes the training program will graduate with an Alberta Completion of Apprenticeship Certificate, Alberta Journeyman Carpenter Qualification Certificate and an Interprovincial Red Seal.

* The most significant benefit to the graduate apprentice is that he/she is well trained technically and practically to make a worthwhile and productive contribution to society. The society in return for the effort will reward him/her with an above average income and opportunity for a successful livelihood.

DIRECTIONS TO PROSPECTIVE CARPENTER APPRENTICES

* Contact your local Apprenticeship and Trade Certification Branch Office for detailed information and counselling.

* Obtain duplicate forms for apprenticeship from the Apprenticeship and Trade Certification Branch and neatly complete in full the information requested of the apprentice.

* Go in person to construction firms who employ carpenters and apply for an apprentice position. Present your apprentice application to the person who interviews you so that he will immediately know who you are and what you have to offer his firm.

* Persevere in the search for apprentice employment and upon obtaining employment, give the application to the employer.

* Attach to the apprentice application a copy (transcript) of your last school year marks. Those applicants who do not have their school transcripts or a grade nine standing will be required to write an entrance examination. The Department of Education will supply your transcripts for a small fee.

* Any time credit, for previous trade experience in carpentry, should be discussed with the employer and requested on the apprenticeship application form by the employer.

* A contract of Apprenticeship is entered into between the apprentice and the employer and should be signed within the first three months after apprenticeship application has been submitted. If contracts have not been issued within this time please contract an Apprenticeship and Trade Certification Branch Office.

* Before signing the contract of apprenticeship, read the complete contract carefully — know what your obligations and responsibilities will be to the employer — know what the employer's obligations and responsibilities will be to you — be sure you have selected the right occupation.

* Be prepared for the technical training classes — school schedule cards and notice to attend classes will be sent to you.

* Prepare in advance for the financial obligations required of you during scool training. Course textbooks and school supplies are paid for by the apprentice.

* While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from the Apprenticeship and Trade Certification Branch.

Apprenticeship and Trade Certification Branch Offices are located in: Calgary, Edmonton, Fort McMurray, Grande Prairie, Hinton, Lethbridge, Medicine Hat, Peace River, Red Deer, and Vermilion.

Staff and facilities for teaching carpentry are located at:

Northern Alberta Institute of Technology
Southern Alberta Institute of Technology
Lethbridge Community College
Keyano College
Lakeland College
Fairview College

(b) After apprenticeship many carpenters specialize in framing, forming, finishing, cabinet work, residential housing, high-rise (heavy) construction, etc., while others work with general construction companies which do a variety of jobs. Each type of construction has its advantages and disadvantages but someone finds satisfaction in each job. Try to learn something about several specialities in the carpentry trade and work at each if possible. Then one can make a career choice much easier.

(c) Once the journeyman certificate has been received, you may want to work your way up in the construction business, as a foreman, superintendent, project supervisor, etc. Not only does this require a thorough knowledge and understanding of basic principles and practices related to construction work, but also the ability to understand and work with people. A sincere interest and enthusiasm in workers and the job itself tends to 'rub off' on other people, making success and enjoyment of a supervisory position more likely. You will need the personality to accept, and indeed look for, new materials, methods, and techniques. You should also acquire some knowledge of other construction trades as well as building codes, zoning codes, and safety regulations.

(d) After gaining your journeyman carpenter certificate and some experience, you may want to start your own contracting business. The opportunities for different types of carpentry businesses are as varied as the carpentry trade itself. You could start a general construction business or specialize in garage building, concrete forming, prefabbing (of buildings or cabinets), finishing work, rumpus rooms, re-modeling and repair, lake cottages, farm buildings, etc. You would be more likely to succeed in any business venture if you learned basic accounting procedures and estimating methods. To build up your business so that you have a steady flow of work, you must earn the reputation of being honest, reliable, and knowledgeable in your work.

(e) The sales and service industry for construction is unlimited in scope and size. There are many positions available for an experienced carpenter, in real estate, lumber yards, building supply centers, numerous companies manufacturing construction products, prefab cabinet firms, prefab housing firms, construction equipment suppliers, tool suppliers, construction equipment rental, etc. This is an extremely wide field.

(f) You may be interested in teaching carpentry at one of the composite high schools in Alberta which offer vocational education or at one of the technical institutes. To teacher carpentry in a high school you will need journeyman carpenter certificate plus a minimum of five years experience after certification. You will also need grade 12 university entrance requirements in order to attend university to acquire a teaching certificate. To teach at this level you need a broad, basic knowledge in the construction field, a good sense of humour, and a genuine liking

and interest in people, especially in young people. Enthusiasm for the carpentry trade and involvement with students is imperative if you decide to be a high school teacher. In a high school you may be the only carpentry teacher. If you would rather work with a group of people in the same trade, teaching at the technical institutes (NAIT, SAIT, etc.) should be your choice.

Apprentices already working in the trade attend a technical institute for two months each year of their four-year apprenticeship. These people have already shown interest in the trade so it is more important for you, as an instructor, at this level, to have a greater knowledge in fewer areas of carpentry rather than a basic, broad background. You do not have to attend university to be able to teach at the technical institutes but your wage-earning capability is higher if you have a teaching degree.

There is a new program at the University of Alberta for senior high school students who graduate from a four-year high school program with both senior matriculation and a vocational certificate in a specific trade area (this high school program is often called a Technical/Matriculation Program). The course at the U. of A. is a special program for graduates who desire to teach their chosen trade.

(g) With a background in construction and an interest and knowledge of safety regulations and safe working techniques, you may be interested in working with the Workers' Compensation Board as a Safety Inspector, ensuring that employees are acquainted with safe procedures and that regulations are followed by employers and employees.

(h) A knowledge of construction procedures and materials would increase your possibility of success if your career was working as a construction estimator. Knowledge and ability in drafting techniques also helps an estimator.

(i) Maintenance carpentry is a growing field. With public institutions such as schools and hospitals, plus apartment buildings, offices, etc. growing in number and size, there is a great need for continual maintenance. A carpenter can start his own business or work for a company as an hourly wage-earner.

(j) Another career in which a carpentry background is extremely important is as a Building Inspector. Centrol Mortgage and Housing Corporation (C.M.H.C.) hires many building inspectors. Large urban areas have many inspectors on staff and most municipalities have at least one building inspector.

OTHER APPRENTICESHIP TRADES

1. Plumbing Program

Plumbing is a four year apprenticeship program dealing with installation, maintenance, and operation of plumbing systems, including hot liquid heating, water supply, water treatment, gas fitting for heating and lighting purposes, and pipe for drains or supply.

2. Roofer Program

The roofing trade involves a three year apprenticeship. This program produces a graduate who is able to understand the principles and practices of roofing (for all different types of roofs). This person is also able to estimate the costs of roofing jobs. He is also trained in the safe use of the tools, materials, and equipment in his trade.

3. Painter and Decorator Program

The Painter and Decorator apprenticeship program is a three year program. This program trains the painter and decorator in the application of opaque and transparent coatings by brush, roller, spray and dipping on any interior or exterior surface. The program also deals with wallpaper, natural, and synthetic fabrics.

4. Bricklayer Program

The Bricklayer program is a three year course which produces a graduate knowledgeable in laying bricks, blocks, and other masonary products.

5. Lather Program

The Lather program is also a three year program. It covers construction of various types of walls and ceilings in commercial buildings. It also covers application of interior and exterior trim.

6. Electrician Program

The Electrician program is a four year program covering the distribution of electrical power within a building. Electricians also connect the lights, fans, and heating systems to the power.

7. Cabinetmaker Program

The Cabinetmaker program is a two year program for the Production Cabinetmaker trade and a four year program for the Cabinetmaker trade. This trade involves the use of wood and wood products for the production of cupboards, shelves, and other funiture.

OTHER JOB OPPORTUNITIES

1. Semi-skilled Jobs

The building construction field has some jobs which could be considered semi-skilled. These involve experience gained on the job or through attending shorter, updating sessions.

Jobs such as a bricklayers helper or carpenters helper fall into this category.

2. Labourer

These jobs are the ones which involve the most physical type work. This would include packing materials to the work area, cleaning up the work area, plus many others.

The pay for these jobs is lower than for the semi-skilled or skilled jobs.

Complete the following exercises and send them in for correction.

EXERCISE 1

1. Should the training in carpentry be quite general or very specific?

   ____

   Give three reasons for your choice.

   (a) ______________________________

   ____

   ____

   (b) ______________________________

   ____

   ____

   (c) ______________________________

   ____

   ____

2. A normal or regular carpentry apprenticeship is of __________ years duration.

3. If you obtain a satisfactory evaluation from a Building Construction 12, 22, 32 (35 credits) in an Alberta Composite High School the apprenticeship time is reduced to

   __________ years.

4. The minimum acceptable education required to enter the carpentry program at

   NAIT is __________ years.

5. Why would a person with only the minimum education have a tough time with the technical courses?

   ____

   ____

   ____

6. What percentage of journeyman carpenter pay do you receive during each year of your apprenticeship?

   1st.- __________ 3rd.- __________

   2nd.- __________ 4th.- __________

7. What type of fee is charged by the technical school for the apprenticeship training?

____

____

8. From whom do you obtain your yearly evaluations towards your journeymans certificate?

(a) ____________________ (b) ____________________

(c) ____________________

9. Why would a carpentry background be extremely important for a job as a building inspector?

____

____

10. How would you go about getting the training to become a building construction teacher, teaching the 12, 22, and 32 programs in an Alberta high school?

____

____

____

____

____

____

____

____

EXERCISE 2

1. Look through your local newspapers and find two job opportunities related to building construction. Cut them out and tape them in the spaces below. List the name of the newspaper each of them came from and the dates they were published. Explain whether the job requires a technically educated person, a semi-skilled or a non-skilled worker.

(a)

TAPE ARTICLE ONE HERE

(b)

TAPE ARTICLE TWO HERE

2. Talk to a tradesman in your community about his training. Comment on the following:

(a) What trade had he apprenticed in?

____

(b) How long was the apprenticeship? ______________________________

(c) What does he like about his work?

____

____

____

(d) Does he recommend it as a vocation? Why?

____

____

(e) Are there any disadvantages to his trade?

____

____

____

(f) Does the job have security?

____

____

END OF LESSON 20